HANDBOOK

OF THE

10-INCH B.L. GUN,

LAND SERVICE.

1904.

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PLATES.

This Handbook has been corrected up to August, 1904. *Any alterations which may be suggested should be forwarded to the Chief Inspector, Royal Arsenal, Woolwich.*

HANDBOOK

OF THE

10-INCH B.L. GUNS, L.S.

ORDNANCE, B.L., 10-INCH.

(Plates I to V.)

	Mark I.	Marks II, III, IIIA, IV.
Material	Steel	Steel.
Length, total	342·2 inches	342·4 inches.
Weight with fittings	32 tons	29 tons.
Preponderance	Nil	Nil.
Bore — diameter	10 inches	10 inches.
Bore — length	320 inches	320 inches.
Bore — capacity, including chamber	29,300 cubic inches	29,300 cubic inches.
Chamber — diameter	14 inches	14 inches.
Chamber — length	54 „	54 „
Chamber — capacity	8,370 cubic inches	8,370 cubic inches.
Rifling — system, polygroove	Hook section, Mark II	Modified plain, section, Mark III.
Rifling — twist*	From 1 turn in 60 calibres at breech to 1 in 30 at muzzle	Straight from breech end of rifling to 202·18 inches from the muzzle, the remaining 202·18 inches, increasing from 0 to 1 turn in 30 calibres at muzzle.
Rifling — length	259·58 inches*	262·18 inches.
Rifling — grooves — number	40	40.
Rifling — grooves — depth	0·06-inch	0·06-inch.
Rifling — grooves — width	0·6-inch	0·6-inch.
Means of rotation	Driving band	Driving band.
Venting	Axial	Axial.
Angle of deflection for drift	1° 30′	1° 30′.
Radius of sights	77·5 inches	77·5 inches.
Firing mechanism	Percussion or electric	Percussion or electric.
System of obturation	Pad	Pad.
Ballistic effects with full charge — muzzle velocity in foot-seconds	2,040	2,040.
Ballistic effects with full charge — muzzle energy in foot-tons	14,891	14,391.
Ballistic effects with full charge — penetration of W.I. at 1,000 yds. in inches	20·7	20·7.

* 2·5 inches at the muzzle of Mark I guns are unrifled.

Mark I Gun.

The gun is made entirely of steel, and consists of the "A" tube, over which are shrunk the breech piece which is prolonged at the rear for the reception of the screw, the 1 B, 2 B, and 3 B hoops, extending to the muzzle. Over the breech piece, and a portion of the 1 B hoop, are shrunk the jacket and trunnion ring, secured longitudinally by interlocking the former with the breech piece, and the latter with the breech piece and 1 B hoop. The 1 C hoop is shrunk over the 1 B hoop immediately in front of the trunnion ring.

The "A" tube is fitted with a steel liner, extending from the seat of obturator to 2·5 inches from the muzzle.

The liner is secured at the breech end by a steel bush, screwed into the breech piece.

The rifling at the muzzle end only extends as far as the end of the liner, the remaining 2·5 inches of the bore being of rather larger diameter and unrifled.

The chamber is cylindrical, terminating in front with a curved slope.

A plane for the clinometer is prepared on the jacket, near the rear and on top.

A bronze frame, for carrying the breech mechanism, is attached to the breech end by fixing screws.

A band for attaching the elevating gear is shrunk over the jacket near the breech. The pattern of the band varies with the nature of mounting.

	Tons.	cwt.	qrs.	lbs.
Weight of breech fittings, including bronze frame, but without elevating band	1	3	1	16

Mark II Gun.

The gun is of steel, and consists of the Alpha tube, over which is shrunk the "A" tube, the Alpha tube being secured at the muzzle by a steel ring. Over the "A" tube are shrunk the breech piece which is prolonged at the rear for the reception of the screw, the 1 B and B 2 hoops. Shrunk over the breech piece are the 1 C hoop and trunnion ring, interlocking longitudinally with the breech piece and 1 B hoop. The 2 C hoop is shrunk over the 1 B hoop, immediately in front of the trunnion ring; the jacket being shrunk over the 1 C hoop at the breech.

The "A" tube is fitted with a steel liner, extending from the seat of obturator to the Alpha tube, the liner being secured at the breech end by a steel ring screwed into the "A" tube.

The gun is of the same total length as the Mark I gun, but the trunnions are 8·1 inches nearer the breech end, and a clinometer plane is provided as for Mark I.

The chamber is cylindrical, terminating in front with a curved slope.

A bronze frame, for carrying the breech mechanism, is attached to the breech end by fixing screws.

	Tons.	cwt.	qrs.	lbs.
Weight of breech fittings, including bronze frame, but without elevating band	1	3	1	26

Mark III Gun.

This gun differs from the Mark II in construction only, and consists of the "A" tube, over which are shrunk the 1 B and 2 B tubes extending from the front of the chamber to the muzzle. At the rear is shrunk the breech piece, partially overlapping the 1 B tube. In front of the breech piece, and over the 1 B and 2 B tubes, are shrunk the 2 C hoop and 3 C hoop. Around the breech piece and a portion of the 2 C hoop are shrunk the 1 C hoop and trunnion ring, interlocking longitudinally with the breech piece and 2 C hoop. The jacket is shrunk over the 1 C hoop at the breech; the D hoop being shrunk over the 2 C hoop, immediately in front of the trunnions.

Mark IIIa Gun.

This gun differs from the Mark III gun in having the 1 B and 2 B hoops substituted for the 1 B tube.

Shoulders are formed on the "A" tube over the powder chamber to give greater longitudinal strength; these shoulders necessitate the breech piece being bushed at the rear for the reception of the breech-screw.

The sight ring is shrunk round the 1 C hoop immediately in front of the jacket.

Mark IV Gun.

This gun differs from the Mark III in construction only, and consists of the "A" tube, over which are shrunk the breech piece, B hoop, and "B" tube, extending to the muzzle. Over the breech piece is shrunk the 1 C hoop, to which it is secured longitudinally by a screwed steel bush at the breech end; the bush is also prepared for the reception of the breech screw. The 2 C and 3 C hoops are shrunk over the B hoop and "B" tube. The jacket is shrunk over the 1 C hoop, and secured at the breech end by a screwed steel ring, the sight ring being shrunk round the front portion of the jacket. The trunnion ring is shrunk over portions of the 1 C and 2 C hoops, interlocking with them. The D hoop is shrunk round the 2 C hoop in front of the trunnions.

Note.—In the case of guns mounted on Mark IV barbette carriages the bronze frame for breech mechanism is prepared to receive the steady pin and locking catch of loading tray.

The following is a description of the mechanisms, which are interchangeable with Marks I to IV gun :—

Breech Mechanism (controlled).

(Plates VI to VIII.)

The breech is closed by a screw having five portions of the thread removed longitudinally, each one-tenth of the circumference. The interior of the gun at the breech being prepared in a similar manner, admits of the screw, when the raised portions are placed opposite the smooth surfaces in the gun, being driven home and locked by the tenth of a turn. In order to lessen the wear of the threads on the

lower surface of the breech-screw while it is being withdrawn or replaced in the gun to take the bearing, a small curved piece of very hard steel, termed "bearing-strip" or "riding strip," is attached to it by screws; the strip is a little higher than the screw threads; a thread is removed from the left lower screwed part of the gun, thus a recess is formed for the breech screw when it is turned to the locked position.

To the outer face of the breech screw is fitted a bronze end plate furnished with a hinged cam lever, by means of which the screw is locked and unlocked. The cam portion of this lever when the breech screw is locked falls into a recess in the carrier ring, and so prevents any movement of the breech screw during firing. On depressing the cam lever after the breech screw is unlocked, the cam acts upon the surface of the carrier ring, partially withdrawing the screw together with the obturator. Thus the lever acts in a fourfold capacity: (*a*) as a lever for turning the screws; (*b*) after turning as a prise, giving the first movement to the rear in withdrawing; (*c*) as the screw is being turned for locking, it acts as a tell-tale, and cannot fall into its position until the turn is fully completed; (*d*) as a lock in the firing position.

A catch for holding the cam lever down, and a catch retaining ratchet lever, are provided.

The cam lever is held in its elevated position by a spring catch fitted to the left lug of the breech screw. In the case of guns mounted on disappearing carriages a spring is fitted to the gudgeon of the ratchet lever to retain the cam lever in the elevated position when the breech screw is locked in the gun.

The lever may be partially lowered for the purpose of releasing the obturator by depressing the lever of the catch.

Encircling the rear end of the breech screw, and hinged to the bronze frame, is a carrier ring, which supports the screw when withdrawn. The ring is provided with bearing rollers to facilitate the movement of the breech screw; and to lessen friction at the hinge, a roller frame with seven coned rollers is fitted.

The carrier ring is held to the gun during the withdrawal of the breech screw by a clip, pivoted within the left side of the ring, engaging with a recess in the bronze frame.

A stop bolt in the right side of the carrier ring prevents the breech screw being disengaged from the carrier when withdrawn; at the same time the clip is disengaged from the recess in the bronze frame by means of a spring, which forces its opposite end into a recess in the breech screw, thus securing the latter in the carrier ring.

In closing the breech the lower arm of the clip is depressed by coming in contact with an inclined plane in the bronze frame, and the clip being pivoted, is consequently released from the recess in the screw, leaving it free to be pushed home.

When the cam lever is elevated it engages a gudgeon projecting from a block sliding in a recess in the upper part of the bronze frame. This block is attached to the ratchet (Stanhope) lever by two links, the short one having the ratchet wheel, which is provided with a reversible double pawl, the arms of which gear by means of a spring pin with the teeth of the ratchet wheel. The ratchet lever pivots on a fixed axis on the upper left side of the breech, and in combination with the links of the ratchet lever, affords great mechanical power in turning the breech screw both in opening and closing the breech.

The double pawl is reversed automatically by means of a tappet attached to the ratchet wheel, which thereby changes the direction of motion round the axis. A small lever is fitted to the pawl for reversing it by hand, when desirable.

Controlling gear.—A rack is fitted to the right side of the breech screw. A pinion, which gears with the rack, is keyed to the hinge bolt. To the bolt is also attached, by means of a nut and keep pin, a worm-wheel, which gears with a worm and spindle fitted to the bronze frame. The whole is so arranged that in turning the spindle in one direction the screw is withdrawn from the breech opening into the carrier ring, and upon further action the ring, together with the screw, is carried into the loading position.

The reverse of this action takes place in closing the breech.

In the event of accident to the controlling gear, the breech screw may be withdrawn, and swung into its loading position by hand, the worm-wheel having previously been removed from the hinge pin, and replaced by a distance piece, which is provided.

To retain the carrier ring open when required, a spring latch is provided, which can be put out of action by means of a lever pivoted on the under side of the carrier ring.

Note.—In the bronze frame of guns mounted on Mark IV barbette carriages there is a hole for the steady pin of loading tray, and a plate (which is secured by screws) for locking catch on the tray (*see* page 34).

Obturation.

The system of obturation consists of a circular pad with protecting discs fitting the mouth of the chamber, placed between the head of the axial vent and the breech screw.

The pad being slightly elastic expands radially when compressed by the action of the powder gas, thus sealing the escape.

Thin discs of steel are used to adjust the required thickness of the obturating pad, as follows :—

Should the obturator be found not to fit the cone seating in the gun correctly (and this can be ascertained by covering the seating lightly with grease and seeing that the obturator is covered all over, after the breech has been closed and opened again) adjusting discs should be added one by one until the breech closes a little tightly through the obturator being pressed forward into the seating. To admit of the adjusting discs being placed behind the obdurator a clearance of about $\frac{1}{10}$th of an inch is provided in the breech fittings to allow of the vent being moved forward, but the whole of this clearance would seldom be required.

The obturating pads should weigh as follows, and if any are found not to be within these limits, steps should be taken to exchange them for others :—

	Minimum.	Maximum.
	lbs. ozs. drs.	lbs. ozs. drs.
Weights	12 15 0	14 2 5

Firing Mechanism.

The firing arrangement is so designed that the gun cannot be fired before the screw is in the locked position, and the cam lever depressed.

It consists of a steel vent furnished with a spring and nut passing through the longitudinal axis of the breech screw, having on its outer end a slide box in which either the electric or percussion locks are moved into and from the firing position, by depressing or raising the cam lever, by means of a link which gears the lock with a groove in the side of the lever,

Lock, electric, "B," and lock, percussion, "D," are used with guns when not mounted on disappearing carriages; and lock, percussion, "J." with guns on disappearing carriages.

Electric Firing.—The electric lock "B" (*Plate VII*) consists of a steel frame having a projecting arm (*a*) in which is an insulated contact (*b*), the upper part of the contact is kept pressed outwards (so as to rub on the frame contact mentioned below) by a spiral spring (*c*) fitted to the lower end of contact is a terminal point (*d*), over which one of the tube wires is placed, aluminium block (*e*) and cap (*f*); but in the case of guns on Mark IV barbette carriage the second terminal point of the lock is also used. The frame is furnished with a spring guide bolt (*g*) engaging with a link attached to the cam lever, by means of which the lock is brought down into the firing position, when the cam lever is depressed. The lower portion of the frame is fitted with an extractor for removing the tube after firing. When the lock is raised, the wedge-shaped extractor is forced under the head of the tube, thus releasing it from the vent. A lanyard (*k*) with toggle is attached to the extractor. To prevent the extractor from flying back on firing, its lower end is prolonged beyond the axis pin, forming a projection (*m*).

A contact frame is fixed on the upper lug of the bronze frame, for the contact (*b*) of lock; this contact frame (except for guns on Mark IV barbette carriage) is furnished with an insulated terminal for the reception of the return wire from the electric vent-sealing tube, *the tube wires being untwisted before use*, one end is attached to the terminal in the lock, and the other end to the upper terminal; with guns on Mark IV barbette carriage both the tube wires are connected to the terminal points of the lock. The contact frame or bracket and electric lock are so arranged that, when the screw is home and the cam lever lowered contact is made. The electric safety firing arrangements will be found described with the carriages, pages 35, 54, 62, and 73, for convenience.

Note.—Failure of the electric system to fire the gun may be traced to the piece of cable within the arm (*a*) of the lock, especially just under the lower contact, which can be unscrewed and the cable examined, and if necessary replaced. The contacts of the lock with the piece of cable are issued spare.

Percussion Firing.—The percussion lock "D" (*Plate VII*), consists of a frame (A) fitted with a striker (B), with firing pin (*b*), spindle (*c*), keep-pin, spiral spring (*d*), and cap retaining (*e*); C, trigger, with axis pin (*g*), and spiral spring (*h*); D, cocking lever, with axis pin (*l*); E, extractor, with axis pin (*n*), spiral spring (*o*), and lanyard (*p*), with toggle; F, guide bolt, with spiral spring (*r*), handle (*s*), and keep-pin.

The guide bolt of the lock fits into a recess in a sliding link, and is

worked up and down by the cam lever; when the latter is raised the lock is cocked automatically. The cocking lever has three arms, the one (*i*) gears into a recess in the slide box causing the lever to revolve, the arm (*j*) pushing the spindle (*c*) back and compressing the main-spring (*d*), which is retained in the cocked position by a projection on the lower part of the trigger catching the lug of the spindle, the trigger being pressed downwards by the small spiral spring on its axis. On lowering the cam lever, the cocking lever is reversed, and its lower arm clears the spindle, which, on raising the trigger, is free to fly forward and carry the striker on to the tube. The third arm (*k*) has its upper surface roughened, and is kept pressed down by the finger while putting the lock in or taking it out of the slide box.

The trigger is fitted with two loops (r^1 s^1), to either of which the lanyard may be attached, one (r^1) being for a horizontal pull to the rear, the other (s^1) for a pull in an upward direction. The lower portion of the frame is fitted with an extractor, similar to that described for the electric lock "B."

The percussion lock "J" (*Plate VIII*) is converted from the percussion lock "D." The frame of the lock is in two parts, and the striker is raised into the firing position, and then released, by means of a trigger and cocking lever, which are so arranged that the lock can be cocked and fired by one pull on the trigger. There is a loop on the outer end of the trigger, to which the lanyard may be attached.

REMOVING AND REPLACING BREECH MECHANISM.

Instructions to be observed in removing and replacing the breech mechanism. Care must be taken not to indent or damage the components: a hammer should never be used unless with a piece of wood or soft metal to transmit the blow: heavy parts which cannot be lifted by hand, can be slung by selvagees, and tackle suspended from the mounting or from any other suitable erection.

The fittings should be examined frequently as to their condition in respect to wear, in order that, if necessary, special examination may be called for.

Removal of Parts.

Before removing the following fittings, the breech should be opened and the breech screw swung into the loading position, except where otherwise stated

Locks.—With the breech screw in the locked or unlocked position.

Electric Lock "B," or Percussion "J."—Place the cam lever in the up position, withdraw the guide bolt of the lock clear of the link, and slide the lock out of the grooves of the slide box in an upward direction.

Percussion Lock "D."—Place the cam lever in the up position, the trigger of the lock must then be pulled to the rear by inserting the third finger of the left hand behind the loop for lanyard, the first finger at the same time being pressed on the hatched position of the cocking

lever. The cam lever must then be gently depressed until the projecting toe of the cocking lever is clear of the recess in the box slide; the lever can then be returned to the up position without cocking the lock, which can then be removed by withdrawing the guide bolt of the lock clear of the link, and sliding the lock out of the grooves of the box slide in an upward direction.

Ratchet Lever.—Remove the keep pin and washer from the axis pin of the ratchet lever, and unscrew the hinge bolt of the link, when the lever can be withdrawn. To remove the sliding block with gudgeon the fixing screw and filling piece must first be removed.

Catch, Ratchet Lever.—Remove the keep pin and washer, and withdraw the catch.

Cam Lever.—Remove the keep pin and nut from the hinge bolt, when the latter can be withdrawn and the cam lever removed.

Catch, Cam Lever, up.—Remove the set screw in the end plate and withdraw the lever from the outside, and the catch with flat spring from the inside of the lug of the end plate.

Catch, Cam Lever, down.—Unscrew the axis pin and remove the lever, the catch with spiral spring can then be withdrawn.

Box, Slide.—With the breech screw locked or unlocked, turn the box slide until it engages with the stop on the end plate, the two portions of the box slide can then be separated to the right and left respectively till clear of the thrust collars on the vent, and withdraw to the rear.

Vent, Axial, and Obturator.—Unscrew the nut from the vent and the latter together with the obturator can be removed from the front end of the breech screw, the spiral spring and washer belonging to the vent can then be withdrawn from the recess in the end plate of the breech screw.

Breech Screw.—Press down the projecting end of the retaining clip in the carrier ring until the inner end of the clip is clear of the pocket in the breech screw, and push the latter through the carrier ring till the stop bolt can be withdrawn from the front of the breech screw. Force back the breech screw through the carrier ring into the loading position, and sling it, press down the retaining clip clear of the screw, when the latter can be withdrawn to the rear.

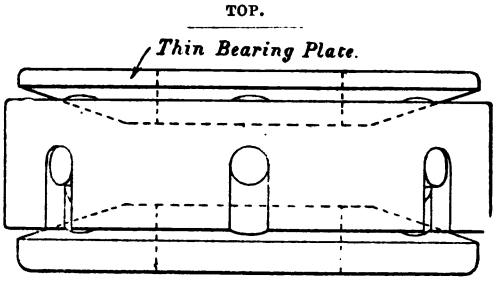
Carrier Ring.—Remove the keep pin and nut from the hinge bolt, care being taken to support the worm wheel while this is being done, the latter can then be withdrawn and the hinge bolt pushed up and removed from above. The rack pinion can then be removed. Sling the carrier ring as near the hinge joint as possible, and push out the steel washer from between the carrier ring hinge joint and the underside of the top lug, then lift the carrier ring till the hinge joint comes against the top lug, and withdraw the carrier ring. In withdrawing the ring care must be taken to catch the roller frame with the rollers and bearing plates, which will fall out at the lower end of the carrier ring hinge joint so soon as the ring is withdrawn.

Worm Spindle.—Take out the keep pin of the lever securing nut, and remove the nut and lever. Knock out the flat keep pin from underneath the bracket and withdraw the spindle, the worm with the four washers can then be removed.

Replacing the Parts.

The order in which the mechanism may be replaced will be the reverse of the foregoing. But, however, in the case of hinge bolt

coned roller frame, care should be taken to put the frame in position as shown in the sketch below; the anti-friction rollers being embedded in tallow or other fatty matter, which will serve to retain them while assembling the frame, and afterwards as a lubricant.



Note.—When examining the breech fittings, care must be taken to test the concentricity of the striker with the tube in the vent. For this purpose a "gauge, striker, eccentricity" is provided, which is suitable to fit in the tube chamber of the vent; in the head of the gauge is a removable plug, upon which the position of the striker point is indicated when the striker is cocked and released with the gauge in position. If the indent made by the striker point in the gauge is found to be so much eccentric as to be likely to cause missfires with either percussion or electric firing, further examination should be made to ascertain the portion of the mechanism in fault, and steps taken to have it repaired or exchanged.

APPURTENANCES, &c. (*Demanded separately.*)

Sights.

The guns are sighted on both sides.

Mark I *foresights* are of the drop pattern, and consist of a pillar, jacket, and socket, with a steel acorn screwed into the pillar. The socket is permanently fixed in a bracket attached to the gun, except in the case of the Marks III A and IV guns, which are furnished with sight rings, having the sockets fixed in them. The pillar locks into the socket with a bayonet joint, and is secured from turning by a projection on the jacket, which drops into a recess in the socket when the sight is in its true position. The sight cannot be removed without first raising the jacket and turning the pillar round a quarter of a circle.

Mark II *foresights* differ from Mark I by being provided with a small steel acorn point and a sighting blade to facilitate laying. The sights are "left" and "right" respectively, and are so stamped, the vertical edge of the sighting blade being turned inwards in each case when the sights are in position in the gun. These foresights are interchangeable with all the L.S. Mark guns.

The *tangent sights* are of steel having bars triangular in section. The front faces have a degree scale graduated to 12°, and a rack which gears with the pinion of the automatic clamp "C." The rear faces are fitted with range strips graduated up to 10,000 yards for a full charge, and stamped with the corresponding M.V.; also in latest manufacture the kind of charge is stamped on them, that is, "P" or "C," denoting powder or cordite. The crossheads are fitted with a deflection leaf worked by a milled head screw capable of giving 2° deflection right and left, and having a sight notch, 0·06 inch deep, for use when elevation and line are both to be obtained by means of the sights.

Mark I tangent sights for these guns were not made specially for the right and left sides, and were used with the Mark I foresights.

Mark II *tangent sights* are made "left" and "right" respectively, and are so stamped. The vertical edges of the sighting blades on the crossheads are turned inwards, when the sights are in position in the guns, so as to correspond with the sighting blades of the foresights.

On the leaf is engraved a zero mark, and the deflection scale is engraved on the corresponding upper face of the crosshead.

The leaf has a vertical sight blade of a height corresponding to about a mean length of 1,000 yards on the yard scale, which is intended for use in conjunction with the elevation indicator, elevation being given by means of the latter, and line only by the sights. When using the sight blade, the sight should be clamped about 1,000 yards less than the estimated range of the ship, if the ship is approaching, and at the estimated range, if the ship is going away, as by this means the gun can be laid for line at any time during the period the ship takes to move 1,000 yards.

The clamp, tangent sight, automatic "C," is used for clamping the above mentioned tangent sights.

Box, Obturating Pads and Discs, B.L., 10-inch.

(*Plate IX.*)

Mark I box differs from Mark II in having iron fittings and screws.

Mark II box is of wood, the sides being made of deal, ends and bottom of elm, while the top, battens, and internal fittings are of mahogany. The sides are dovetailed to the ends, and the bottom is secured by brass screws. It holds three pads and three sets of discs.

The box is fitted with a false lid (*a*), a gunmetal bolt passes up through the bottom and both lids; each lid is secured with a fly nut (*bb*), both nuts being on the before-mentioned bolt. The false lid thus secures the pads and discs in the box by having the fly nut screwed down upon it; *see* also care and preservation of ordnance in "Regulations for Care and Preservation of War Matériel, &c."

Round the top of the box, under the lid, sheet felt is secured with shellac and tacks, to make a tight joint. On top of the lid there are two metal plates, each having a folding down handle for lifting purposes, secured by screws; there is also a recess to contain a label of instructions.

The interior of the box is coated with paraffin wax, and the exterior is painted.

For dimensions, *see* the Plate.

Box, Spare Parts.

The box, spare parts, is made of deal, divided into 17 compartments, and is intended to hold the spare springs and other small parts belonging to the gun.

Clinometer, Large, Mark I.

This instrument is fitted to a metal drum which is graduated to 45°. For method of using clinometer and its care, *see* "Garrison Artillery Training," Vol. I. When not in use, the clinometer is kept in its leather case or wood box; the latter will be obsolete when stock is used up. Either is a separate store to the clinometer.

Implements.

The proportion of implements allowed will be found in the Equipment Regulations.

Description.	Marks of Guns, 10-inch B.L., for which used.
Bit, vent, 36-inch	All the marks
Borer, tube chamber { square end .. .. / pointed end .. .. }	All the marks using cordite charges
Gauge, striker { eccentricity .. .. .. / protrusion, No. 3 .. .. }	All the marks
Ordnance, B.L.—	
Bolt, eye, breech screw	All the marks
Lever, extractor	
Wrenches—	
Fixing mechanism { E .. .. .. / L .. .. .. }	All the marks All the marks (guns on disappearing carriages)
Nut, vent, 12-inch, Marks I to VII, and 10-inch	All the marks
Rimers, vent, { long .. .. / axial short, Mark IV .. .. .. }	For guns using cordite primers All the marks
Wrenches, stud and screw, No. 1	All the marks

The above-mentioned implements will hardly need to be described, except, perhaps, the following:—

Ordnance, B.L., Lever, Extractor.

This consists of a steel rod, about 9 inches in length, having toe pieces at either end, which may be inserted in the loop of the extractor, to which the lanyard is attached, the sides of the lock frame affording a fulcrum. It is intended for prising up the extractor of the lock in the event of it failing to withdraw the tube when the lanyard is pulled.

Description.	Marks of Guns, 10-inch B.L., for which used.
Brush, piasaba, B.L. bore, 10-inch, Mark II (for end stave)	All the marks
Extractors—	
Cartridge, B.L., 10-inch to 8-inch	All the marks
Drill shell, No. 2 (*see* also page 105)	
Lanyards, friction tube, Nos. 3 and 5	
Rammer,* B.L., 10-inch and 9·2-inch	All the marks
Rammer and sponge, B.L., 10-inch (combined) ..	All the marks
Scraper, B.L. ordnance, 6-inch to 13·5-inch	All the marks (with powder charges)
Sponges, B.L., 10-inch—	
Bore (for end stave)	All the marks
Chamber*	
Stave, end, B.L., 10-inch and 9·2-inch (16 feet long)	All the marks, for lengthening brush and bore sponge (where still in use) staves
Covers—	
Breech, B.L., 10-inch, Mark IV gun	I to IV
Muzzle, B.L., 10-inch { Mark I gun	I
Muzzle, B.L., 10-inch { Marks II to IV guns ..	II to IV

* Will be replaced by combined rammer and sponge.

Brush, piasaba.—The brush is used for cleaning the bore of the gun, in conjunction with a sponge cloth or piece of canvas tied on the head.

The head is of elm, having piasaba tufts secured into it by pitch or marine glue.

The stave is of pine or ash, and is secured in the head by a copper rivet. It is fitted with a metal socket joint, which consists of a metal plug fixed to the stave end, and a metal cylinder fixed to the brush stave; the plug is inserted in the cylinder, and secured in position by a thumb screw fitted to the cylinder.

Total length, with end staves, 33 feet 4¾ inches.

Extractors.—The cartridge extractor is a copper hook secured in a wood stave. The total length is 10 feet.

For drill shell extractor, *see* page 105.

Lanyards.—The friction tube lanyards are of tarred white line.

No. 3 is used with guns on barbette carriages; it is fitted with toggle and loop, and the length is 8 feet 8 inches, but may be shortened locally, as required, to suit the particular guns.

No. 5 is used with guns on disappearing carriages, when using shield sights; it is fitted with a toggle, and the full length is 16 feet.

Rammer.—This pattern of rammer (Mark I) is being used up. The head is of elm, and the stave of pine or ash; the stave is secured to the head by a copper rivet. A brass screw is inserted in the stave 37 inches from the outer face of the rammer, to denote the half-way position of the projectile in the bore of the gun.

Total length of rammer over all, 12 feet 6 inches.

Rammer and Sponge.—The combined rammer and sponge (Mark I) consists of an elm head which is covered with fleecy hosiery secured on with marine glue, and it is strengthened by a brass ring at the

front. The stave is of ash and secured in the head by means of a copper rivet; it is 12 feet 2 inches long.

Mark II differs from Mark I in having six holes, for lightening purposes, bored longitudinally from the rear and then plugged up; the fleecy hosiery is further secured by the brass ring in front, and by means of thread in a groove in rear. A denoting boss-head screw is inserted in the stave 37 inches from the rammer face.

Total length of rammer and sponge, 12 feet 6 inches.

Scraper.—This is for use in cleaning the chamber of the guns after firing with powder charges.

Mark I is similar to Mark II but the scraper portion is of steel which was found to be too brittle at the edge, and liable to be chipped and broken.

Mark II consists of an ash stave, with one end formed into a head, on one side of which is riveted an aluminium bronze scraper, and on the other a brush. The stock of the brush is of beech, to which tufts of bristles are secured by brass wire.

Total length, 6 feet.

Sponges.—The bore and chamber sponges are being used up. The heads are of elm covered with fleecy hosiery. The staves are of pine or ash and secured in the heads by a copper rivet.

Stave, end.—This stave is for lengthening the staves of the piasaba brush, or bore sponge. It is of pine or ash, and fitted with a metal plug to suit the socket joint on the rammer stave (which *see*).

Length, 16 feet.

Covers, Muzzle, Breech.—These are of waterproofed canvas, and secured on the gun by straps.

CARE AND PRESERVATION OF ORDNANCE AND THEIR FITTINGS, AND AIMING RIFLES.

See "*Regulations for Care and Preservation of War Matériel, &c.*"

RIFLE, AIMING, 1-INCH, MORRIS, B.L., MARK I.

(*Plate X.*)

This apparatus is for use with the gun in imparting instruction in laying, and consists of the following parts:—

Rifle, aiming, 1-inch, Morris, B.L.—

Barrel, 1-inch, 6-inch to 13·5-inch guns (Marks I or II)	Steel, with two washers, collar set screw, and spiral spring.
Breech-piece, 6-inch to 13·5-inch guns (Mark I)	Steel, in two parts, with set screw, handle, two heads (one electric and one percussion), two extractor clips, striker, and spiral spring.

Block, retaining, electric needle, 9·2-inch, 10-inch and 12-inch guns (Mark I)			Steel, with guide bolt, head keep pin and spiral spring.
Discs, extracting (Mark I) ..			Steel (10 to a set).
Frame, expanding, 10-inch (Mark I)			Bronze, in two parts, with expanding screw, two washers, and two nuts.
Needle	electric, 10-inch (Marks I and II)		Steel, with plunger, spiral spring, head, and securing nut and terminal.
	percussion, 10-inch	Mark I	Steel, with head, spiral spring, and securing nut.
		Mark II	Steel, with head, spiral spring, adjusting nut, and dummy tube with securing nut.
Tube, 0·23-inch "E" (Mark I)			Steel, with nut and washer; rifle, aiming, 1-inch, Morris, B.L.

Implements used.

Rifle, aiming, 1-inch, Morris, B.L.—				
Tommy		Steel	.. .. ..	1
Wrenches	breech-piece ..	Steel	.. .. ..	1
	discs, extracting ..	Steel	.. .. ..	1
	expanding, 10-inch and 9·2-inch	Steel	.. .. ..	1
	needle	Steel	.. .. ..	1
Rifle aiming, 1-inch—				
Brush, cleaning		Without rod	.. ..	1
Rod, cleaning		Wood	.. .. ..	1
Tube, aiming, 0·23-inch—				
Brush, cleaning		Without rod	.. ..	1
Rod, cleaning		Steel, 36 inches long	..	1

The 1-inch barrel (*a*) is 35½ inches long, chambered and rifled on the Henry principle, having 11 grooves with a twist of one turn in 60 inches in Mark I barrel, and one turn in 35 inches in Mark II; the length of rifling is 31½ inches. A steel breech-piece (*b*) is fitted to the rear end of the barrel, which is provided at the front end with a screw thread having three interruptions cut upon it; the interior of the barrel being prepared in a similar manner admits of the breech being closed and the breech-piece locked in position by the sixth of a turn.

The breech-piece is in two parts (*b*, *b'*), secured by a screw thread and set screw, and is furnished on the exterior with a sliding collar (*c*), provided with two handles, to facilitate insertion and withdrawal. The rear portion is furnished with a striker (*d*) and spiral spring, and the front portion prepared for the reception of two heads (one for electric and one for percussion firing), through the centre of either of which the point of the striker passes. Extracting clips (*e*), which engage with the base of the cartridge case, are fitted to the front portion of the breech-piece, for extracting the cartridge case when the breech-piece is withdrawn.

The retaining block (*f*) is of steel, and is used in place of the gun lock when firing the 1-inch electric cartridges. The block fits in the slide box of the gun and has at its upper end a spring guide bolt, somewhat similar to that of the gun lock; the lower portion of the block differs from the gun lock in being made forked, so as to clear the connecting wire of the Mark I electric needle, or the plunger of the Mark II, when brought down into the firing position.

Fitted to the exterior of the barrel is a bronze frame (*g*), furnished with an expanding screw (*h*) and nut for securing it in the chamber of the gun. The frame is furnished with a steel feather, which engages with a longitudinal recess on the barrel, and forms a guide for the barrel when in position. A spiral spring (acting as a buffer) and two washers are fitted over the barrel at the rear of expanding frame. A steel collar (*i*) screwed over the barrel at the muzzle and secured by a set screw forms a stop, and serves to prevent the barrel being withdrawn from the expanding frame when in the gun.

The rifle is fired by means of the firing mechanism of the gun, for which purpose two steel needles are provided (one for electric and one for percussion firing). The needles (which are furnished with heads similar in form to the vent-sealing tubes used with the guns) are intended to pass through the vent channel of the gun, and make contact with the outer end of the striker. The Mark I electric needle and the Mark I percussion needle differ from each other in the former being insulated and furnished with a lead, which is placed over the terminal of the lock. The needles vary in length, to correspond with the length of the vent channel of the gun in which they are intended to be used. Mark II electric needle differs from Mark I in the form of attachment for connecting the wire to the electric needle, *i.e.*, the interior of the head of the needle is fitted with an insulated steel plunger, which is actuated by a spiral spring. One end of the plunger is fixed to the needle, the other end projecting through the head to the rear where it is coned for the reception of a screw terminal, by means of which the insulated connecting wire is attached. Mark II percussion needle differs from Mark I in being made sufficiently hard to prevent bending or burring; it is also tapered to a smaller diameter to the rear, and so arranged in the dummy tube as to admit of its being used with vents in which the vent channel and tube chamber are not concentric.

The 0·23-inch aiming tube "E" is of special pattern. It is furnished with brass collars, which fit the bore of the 1-inch barrel, and is secured by a nut and washer at the muzzle.

Method of Fitting and using the Apparatus.

The screwed collar is removed from the muzzle end of the 1-inch barrel, and the spiral spring, washers, and expanding frame placed over the barrel from the muzzle; the screwed collar is then replaced and secured by the set screw. The apparatus is placed in the chamber of the gun in such a position as will admit of the outer end of the breech-piece engaging with the inner end of the axial vent of the gun when the breech is closed. The bronze frame is expanded so as to secure the apparatus in the chamber by turning the expanding screw to the right by means of the wrench provided for the purpose; the axes of the gun and 1-inch barrel will then coincide.

When the breech of the gun is closed, the electric or percussion needle will be placed in the vent channel, and the "block, retaining, electric needle" or the "lock percussion" put in position as required, according to the respective systems of firing. The apparatus can then be fired by the firing mechanism of the gun.

Elevation is obtained by means of the gun sights, and any error in line will be corrected by use of the deflection scale.

The 0·23-inch aiming tube E is placed in the 1-inch barrel (from the breech), and secured at the muzzle end by a nut and washer.

Note.—When the aiming rifle is used in guns mounted on Mark IV barbette carriages fitted with automatic sights, to give increased practice in laying with the sights, the ordinary cam of the gear will be substituted by a cam cut to the range limit of the aiming rifle.

Care and Preservation.

All actions and parts of the rifle and tube should be kept perfectly clean and oiled, so as to keep them in good working order and prevent rust. No cutting material, such as emery cloth, is to be used for cleaning.

Ammunition Used.

Cartridges, aiming { rifle, 1-inch electric. / „ „ percussion. / tube.

For description, *see* page 100.

CARRIAGES AND SLIDES.

Description.	Elevation in degrees.	Depression of degrees.	Height of axis of trunnions above the racer in firing position.	Weight.		Diameter of trucks.		Radius of racers.	
				Carriage.	Slide.	Front.	Rear.	Front.	Rear.
			ft. ins.	tons cwt.	tons cwt.	ins.	ins.	ft. ins.	ft. ins.
Carriages, garrison, B.L., 10-inch—									
Barbette — Mark I	15	6½	..	11 4	..	..	..	..	..
Barbette — „ II	17	5	..	11 3	..	..	..	..	..
Barbette — „ III	15	5	..	7 3·5	..	..	..	..	..
Barbette — „ IV	10	10	6 7·5	†	..	..	..	..	..
Slides, L, B.L., 10-inch—									
Barbette — Mark I — C pivot	..	..	9 2	..	9 13·25	Roller	ring.	5 11·13	5 11·13
Barbette — Mark I — D „	..	..			10 11·5	24	24	9 6	3 8·25
Barbette — „ II	..	..	9 8·5	..	45 11	18	18	10 10	10 10
Barbette — „ III	..	..	9 4·8	..	41 16·5				
Carriages, garrison, B.L., 10-inch—									
Disappearing — Mark I	15	5	15 3·1	60 11	..	Roller	ring.	6 0	6 0
Disappearing — „ IA			15 3·1	..	..			..	..
Disappearing — „ II	15	5*	15 11	..	..			10 2·45	10 2·45

* 7½° if emplacement admits.

† Weight of carriage on racer (Mark IV) not yet ascertained.

NOTE.—For *Special Implements* used with the above-mentioned mountings, *see* Equipment Regulations.

CARRIAGE, GARRISON, BARBETTE, B.L., 10-INCH, MARK I.

For slides, *barbette*, C and D pivots, Mark I, pages 44 and 45.

(*Plates XI to XIII.*)

The mounting is constructed to fire "en barbette" over a 7 feet 6 inches parapet; it allows a recoil of 52 inches, *see* hydraulic buffer.

The carriage consists of two steel double-plate brackets connected by front and rear transoms, of the same material, and mounted on 10 steel "Rollers, carriage, No. 8," bushed with phosphor bronze. It is fitted with a straight shield (curved in earlier manufacture); two hydraulic buffers in tension, which recoil with the carriage, to control recoil; frictional elevating gear; and a running-back pump for use at drill, &c.

The carriage when mounted admits of 15° elevation, and 6½° depression. A stop is fitted to the front transom of carriages in which it is found that the elevating arc can run out of gear, so as to limit the depression obtainable to 6½°.

Hydraulic Buffer.

(*Plate XIII.*)

The cylinders A are of forged steel, and are fixed to, and recoil with, the carriage. The piston rods B pass through the front of the cylinder, and are attached to the front of the slide. They are fitted at the rear with pistons, containing a rotary valve C. The cylinders are fitted with a filling plug D, and a drain plug E.

Controlling rams EE are fitted to the rear cap of the cylinders.

Piston Valve.—The pistons are fitted with a gunmetal rotating valve C, with two ribs (H), which fit into rifled grooves L, in the cylinders. Ports (J) are cut in the piston, and corresponding ports K are cut in the valves.

To fill the buffer, care of, &c., *see* page 64.

Action of Hydraulic Buffer.—When the carriage is in the firing position, the port is full open. As the carriage recoils, the valve C is rotated by the ribs H sliding in the rifled grooves L in the cylinder, thus gradually closing the port, until it is completely closed, when the carriage is at extreme recoil. The resistance thus offered to the passage of the liquid through the port is sufficient to overcome the energy of recoil in a length of travel of 52 inches, as shown on the inscription plate. The pitch of rifling and the form of the openings are so arranged that the velocity of the liquid through the port is the same at any position, thus causing a uniform pressure in the cylinder during recoil, and reducing to a minimum the strain upon the pivot and foundations.

As the carriage returns into the firing position, the controlling ram EE enters the hole in the rear end of the piston rod, and displaces the liquid which has passed into the hole when the carriage was at extreme recoil. The clearance between the ram and the hole is so small that a considerable resistance is offered to the motion of the gun and carriage, and thus they are prevented from running out violently against the front buffers of the slide.

Running-back Pump.

The running back pump is *for drill purposes only*. The bye pass valve, worked from the wheel near the pump handles, must be closed before commencing to pump the carriage back, and opened to run it up. Before firing particular care must be taken to close this valve to prevent the air which gets into the hydraulic buffers being forced into the tank on running up, and so causing an overflow. If the carriage does not run up completely owing to air in the buffers, this valve should be opened to release the air gently, and closed again before firing; and to prevent the spindle of the valve being unscrewed too far, a metal collar is fitted to the spindle so as to admit of about two turns being given to it.

The pump (in the tank L′, Plate XIII) is worked by the handles M, which by means of a crank acting on the plungers, force the liquid into the hydraulic buffers through the pipe P when the valve N is open, and the pressure acting upon the piston, runs the carriage back; when the carriage runs up, the liquid is forced back again from the hydraulic buffer into the tank.

Elevating Gear.

(*Plate XIII.*)

The elevating gear is fitted on the right side of the carriage, and consists of toothed gear, actuated by a handwheel A.

The handwheel is fixed on the spindle E, which is carried by a brass casing which covers the gear, and has a pinion formed on it. This pinion engages the spurwheel D, which is carried on the spindle C, and is free to rotate on it. On the inner extremity is fixed a pinion B, which engages the arc on the gun. The gear is provided with a compressor friction clamp, which acts in the following manner:—The steel friction rings are attached to and rotate with the spindle C. They engage alternately similar rings of gunmetal, which are keyed to, and rotate with the spurwheel D.

These rings are pressed together by the nut I. The pressure on the spring disc H is adjusted by the nut I, so that the friction between the rings is sufficient to elevate or depress the gun, but will allow the gun to move without giving motion to the whole of the gear when any great strain comes on it, such as occurs when the gun is fired. Two $\frac{1}{4}$-inch tapped holes are now provided, in order that the rings may be readily withdrawn when necessary.

To Adjust the Friction of Elevating Gear.—Slacken the nut I, then screw it up gently against the disc H until the gun just moves when the handwheel A is turned. Great care should be taken not to tighten the clamp more than necessary.

Before the gun is mounted, the paint must be scraped off the trunnion arms, and burrs, if any, removed, to ensure its turning freely in the trunnion bearings, and consequently the easier working of the elevating gear.

Elevation Indicator.—The angle of elevation is indicated by a degree scale plate, keyed to a small pinion spindle, which is actuated by a toothed piece fixed to the elevating arc.

A yard scale plate graduated for yards of range corrected for heights of gun above mean tide level, muzzle velocity of the gun, and

the nature of the mounting is secured over the degree scale plate. When laying by quadrant elevation the degree or yard scale plate revolves and the degrees or yards of range are indicated by an arrow-head engraved on a metal pointer, which is fixed to the carriage.

Electric Firing Gear, see page 73.

CARRIAGE, GARRISON, BARBETTE, B.L., 10-INCH, MARK II.

For slide, *barbette*, Mark II, page 46.

(*Plates XIV and XV.*)

This mounting is constructed to fire "en barbette" over an 8 feet parapet, with 17° elevation or 5° depression; and to allow a recoil of 8 feet, as shown on the inscription plate.

The carriage is fitted with two hydraulic buffers in tension to control recoil, and with 14 rollers to ensure its automatically "running up" immediately after firing; provision is also made for running the carriage back by means of a pump, which is used for drill purposes only.

The carriage consists of two cast steel bracket sides, connected by a transom of similar material, to which they are fixed by dovetailed joints and steel bolts.

The brackets are each cast with ribs to increase the strength; with deep trunnion bearings to dispense with capsquares; and with pockets for the rollers.

Each bracket is bored out to take a steel cylinder for the hydraulic buffer, which is closed at each end with a steel cap. The front cap is fitted with a steel stuffing box, and with a metal gland for tightening the packing round the piston rod.

The buffers are designed to give an approximately constant pressure during recoil. For this purpose they are fitted with taper bars, and apertures in the pistons, which can be altered in area by turning the piston rods; the resistance of the buffers is thus adjusted to suit varying charges.

The piston rods are turned by means of a connecting bar which is attached to their front ends by short levers, and a graduated scale is fitted on the front of the slide to indicate the amount of adjustment.

The cylinders are connected by a copper tube so that the quantity of fluid will always be the same in each buffer, to ensure equal pressure in both. A phosphor bronze plunger is fixed to the rear cap and enters a cylindrical hole in the piston rod. The hole being slightly larger than the plunger, the arrangement acts like a small hydraulic buffer, to prevent violent concussion when running up.

The rollers are of steel, bushed with phosphor bronze, and revolve on steel axles, which are kept in position by iron plates (*a*), screwed to the carriage sides. Eight "Rollers, carriage, No. 22," two at each corner of the carriage, are flanged on the inner side to serve as guides to the carriage; six "Rollers, carriage, No. 21," being placed at intermediate points between the front and rear sets. By removing the plates (*a*) the axles and rollers can be taken out for cleaning, &c., without lifting the carriage.

Rear clips cast on the inner side of the bracket sides, and steel front clips bolted on at (*b*), keep the carriage on the slide when firing.

The running back gear consists of a double-acting pump in a cast-iron cistern (W), connected to the buffer by means of a copper pipe, coupled to the hole for the right filling plug; the pump is hung on the right carriage bracket by two iron clip hooks, and is worked from the ground by means of a double-handled lever (*q*), with stop to regulate the length of the stroke. The releasing valve is worked from the bottom of the cistern by a handwheel, and a draw-off cock is provided for emptying the cistern. A portable derrick, with chain block, is fitted to the top of carriage bracket, for use when attaching and removing the pump. See also care and preservation, page 66.

Elevating Gear.

The elevating gear is on the right side of the mounting, and is actuated by a hand-wheel (A), on the first motion shaft (B), which carries a bevel pinion gearing with another bevel pinion on the end of the second motion shaft (C); this shaft has a featherway between centre and rear brackets for gearing and revolving a bevel pinion on the shaft. These shafts are supported in suitable brackets and bearings on the side of the slide.

Secured to the side of the carriage is a bracket (D), which slides on the second motion shaft and supports, vertically, the third motion shaft (E), fitted with a bevel pinion on its lower end, which gears with the one on the second motion shaft, and a spur wheel on its upper end gearing with another spur wheel on the vertical worm shaft (F), the worm of which drives the worm wheel (G) working on a spindle; on the inner end of this spindle is the arc pinion which gears with the teeth on the front of the arc (H), secured to the gun. A certain amount of slip is allowed to the gear by the friction cones of the worm wheel.

The arc is secured to the elevating band on the gun by two steel pivots.

The upper half of the arc is furnished with teeth to gear with the arc pinion, on the lower half the teeth are cut with a smaller pitch to suit the pinion on the shaft of the elevation indicator.

The gear is secured to the carriage by suitable brackets; the spur wheels on the third motion and worm shafts are covered by a steel guard, and the worm wheel by a metal one.

Elevation Indicator Gear.

A graduated metal disc (I) is secured to the side of the carriage in front of the elevating gear, elevation is recorded upon it by an aluminium pointer (J) on the end of a spindle which passes through the disc, the spindle is actuated by a pinion in gear with the elevating arc.

For electric firing gear, *see* page 73.

	ft.	in.
Height of carriage (centre of trunnions)	3	0
Length of carriage	10	6

CARRIAGE, GARRISON, BARBETTE, B.L., 10-INCH, MARK III.

For slide, *barbette*, Mark III, page 48.

(*Plate XVI.*)

This mounting is constructed to fire "en barbette" over an 8 feet parapet, with 15° elevation and 5° depression, and to allow a recoil of 8 feet, as shown on the inscription plate.

The carriage is fitted with two hydraulic buffers, with rods in tension to control recoil, and with 10 rollers to ensure its automatically running up immediately after firing. Provision is also made for running the carriage back by means of a pump, which is used for drill purposes only.

The slide is fitted with suitable gear for training and elevating the gun, and with stop brackets, which transfer the shock of the recoil to the front of the racer. The mounting is traversed round a central hydraulic pivot by four men working on winch handles.

The carriage consists of two cast iron brackets, with a steel plate on each side, the inner plates being deep enough to form a well in which are fitted the hydraulic buffers. The brackets are connected by three plate and angle transoms and a bottom plate. The trunnion bearings have a deep "sink" to dispense with capsquares.

The buffers are designed to give an approximately constant pressure during recoil, by having the bore of the cylinders slightly tapered for about two-thirds of their length, so that the clearance space between the piston and cylinder may form a varying orifice for the flow of the liquid.

The cylinders are connected by a copper tube to equalise the quantity of liquid in each buffer, and preserve an equal pressure in both. A phosphor bronze plunger is fixed to the rear cap, and enters a cylindrical hole in the piston rod when the carriage runs out; the hole being only slightly larger than the plunger, obstructs the escape of the liquid contained in it, and serves as a small hydraulic buffer to prevent violent concussion when running up.

The "Rollers, carriage, No. 20," are of steel, bushed with phosphor bronze, and revolve on steel axles, which are kept in position by iron plates screwed to the carriage sides. By removing the plates the axles and rollers can be readily removed for cleaning, &c., without lifting the carriage.

Rear clips (*s*) bolted on the inner side of the bracket, and front clips (*t*) bolted on the outer side, keep the carriage on the slide when firing.

The elevating gear is constructed as follows: A longitudinal shaft (*u*), fitted to the right side of the slide, is rotated by a hand wheel (*a*) by means of a cross spindle and mitre wheels, a sliding pinion (*w*) which works a vertical worm shaft (*x*) and worm wheel (*y*), attached to the carriage. The spindle of the worm wheel has a pinion which gears into the elevating arc (*b*), fixed by a band to the gun. A certain amount of slip is allowed to the elevating gear by means of a cone fixed on the worm wheel spindle, and which fits into a corresponding recess in the worm wheel. The cone is forced into the recess

by a steel disc spring, which can be adjusted on the spindle to regulate the amount of slip. The elevation and depression in degrees, and the range in yards, are shown by the indicator A.

The running-back gear consists of a double-acting pump in a cast iron cistern (B), connected to the buffers by a copper pipe, coupled to the hole for the right filling plug. The pump is hung on the right side of the carriage by two brackets, and secured with keys. It is worked from the ground by means of a double-handled lever (D), with a stop to regulate the length of the stroke. The releasing valve is worked from the bottom of the cistern by a handwheel; and a draw-off cock is provided for emptying the cistern. A portable derrick (*v*), with chain block, is fitted to the top of the carriage bracket for use when attaching and removing the pump.

For electric firing gear, *see* page 73.

	ft.	in.
Height of carriage (centre of trunnions)	4	0
Length of carriage	9	6

CARRIAGE, GARRISON, BARBETTE, B.L., 10-INCH, MARK IV.

(Plates XVII to XXIV.)

This mounting is constructed for firing "en barbette" from a pit emplacement, 22 feet in diameter and about 9 feet 6 inches deep, and generally consists of a cradle, carriage, live roller ring, pivot plate, pedestal and holdfast. Gears are provided for the purpose of loading the gun, elevating, elevation indicating, traversing, sighting and firing; also protecting shields.

The gun, which is connected to the cradle by means of a trunnion band, recoils 3 feet axially in its cradle.

Inscription plates containing instructions respecting the working, are attached to the cradle, carriage, and accumulator.

For elevation, depression, weights, &c., *see* table, page 21.

To mount the carriage, gun, &c., *see* page 68.

Band Connecting Gun with Cradle Buffer.

This band (C, Plate XIX) is of steel, cast in two parts, lower and upper; the lower part is prepared to receive the gun trunnions; a projection along each side of the band fits into a corresponding guide recess (*a*) in the cradle (D), the bearing surfaces of these sliding projections have attached to them manganese bronze anti-friction plates, which are secured by metal rivets, and the under plate is provided with oil grooves; on the underside of the band is a projection with a hole to receive the front end of the hydraulic buffer cylinder; the upper part or cap is put on over the gun, and secured to the lower part by large screws on each side.

The compressor rams (*b, Plate XVIII*) are secured to lugs or projections on the underside of the band, one on each side.

The gun with band and buffer cylinder recoil together.

Cradle.

(*Plate XIX.*)

The cradle (D) is built up of steel castings, consisting of two sides (*c*), 8 feet 5 inches long, with trunnions, and recessed on the insides for the projections on the gun band, grooved to contain lubricating material, and connected at the ends by a front and rear transom bracket. The front bracket (*d*) is prepared for the reception of the piston rod of the hydraulic buffer. The rear bracket (*e*) is cast to take the air chamber, bronze anti-friction liners being let in on its upper hollow for the gun; it is also prepared to receive the cylinders (*f*) of the hydraulic compressors.

The left trunnion is cast hollow and prepared for the elbow pipe of the hydraulic system, the hollow is continued along the side of the cradle to the rear, where it is connected to the recoil utilising cylinders of the hydraulic gear.

A cast steel elevating arc (*g*) is bolted to the underside of each of the cradle sides, the arcs being connected and strengthened by two tie bars through distance tubes and secured on the outside by nuts and split keys.

The arc (*h*) of the elevation indicator is secured to the underside of the cradle at the left side. Two gunmetal capsquares on the top of the cradle sides secure the gun in the cradle.

Ball bearings, Plate XIX.—The cradle is provided with ball bearings which decrease the friction in elevating. This anti-friction ball bearing is fitted on the outer end of each trunnion; each bearing consists of 24 hard steel balls (a^1), which work in a groove formed by two hard steel bevel rings (a^2) secured by a metal adjusting nut screwed on to the trunnion, consequently these revolve with the cradle; over the balls is a steel band having on its inner circumference a hard steel bearing ring, which is let in and secured by a retaining steel ring and three screws on the inside face; there is a socket (a^3) formed on the underside of the band for the supporting screw (a^4) of ball bearing; this screw has a cylindrical head, to fit the socket just mentioned; below it is a hexagon shoulder to take a spanner, the lower part of the screw being threaded to screw into a corresponding hole in a projection (a^5) on the carriage side; a pair of No. 46 spring discs is arranged on the cylindrical part of the screw to take the weight on firing. Movement of the cradle in its bearings is rendered easy by the adjustment of the supporting screws.

Hydraulic Buffer and Air Chamber.

(*Plate XIX.*)

The hydraulic buffer (E) is in tension, the cylinder forming the ram of the air chamber; the piston rod and air chamber are secured to the brackets of the cradle. The gun band (C) takes the cylinder of the buffer, which is retained by a screw collar of steel screwed on to the front of the stuffing box; a steel feather, let into the cylinder and band underneath prevents the cylinder turning in its housing. The rear bracket carries the air chamber to which it is secured. The piston rod is connected to the front bracket of the cradle by a screw collar in rear and a nut (*i*) and keep pin in front.

The buffer admits of 3 feet recoil, and will hold 6½ gallons of liquid.

The *cylinder* is of steel, and is 5 feet 4·8 inches long and 13 inches diameter, over all, and is sheathed with gunmetal, to prevent scoring the bearings of the air chamber, the sheath being 4 feet 4½ inches long, and secured to the cylinder by an undercut groove in front and by small screws in rear; internally there is a manganese bronze valve key which fits into an undercut groove in the cylinder and is secured by a screw, and a shallow groove cut in the cylinder allows air to escape over the piston head on recoil; the front end of the cylinder is prepared for the large or inner gland which is screwed in, and which contains an L-leather; the stuffing box for hydraulic packing screws into this inner gland, the packing being tightened up by a small or outer gland which screws into the stuffing box; the rear end is prepared internally for the reception of the controlling ram, externally it is cupped out so as to offer a large surfare to the air in the chamber. Filling and emptying holes are provided, *see* Care and Preservation, page 68.

The *piston* with rod is of steel, 6 feet 0·3 inch long, over all, 6 inches diameter, bored out internally for the controlling ram and manganese bronze adjusting valve tube. The piston is 9·5 inches diameter, over all, two manganese bronze rings are let into undercut annular grooves to prevent wearing the cylinder by scoring; there is also a 3-inch port for the valve key of the cylinder. The piston rod is screw threaded in front for the connecting collar and nut respectively.

The *controlling ram* is a steel rod 2 feet 5 inches long, over all, and 3 inches diameter, tapered at the point; it screws into the rear end of the cylinder. A channel is bored along the centre, terminating radially near the base, for the passage of fluid from the hole in the piston rod; the point is furnished with inlet holes, and is threaded to take the adjusting valve; the latter is made of forged steel, 4 feet 3 inches long, over all, grooved longitudinally, and is screwed into the controlling ram from the front end of the piston rod, from where it is also adjusted; for which purpose there is a metal plate, having eight holes bored in it, and marked 0 to 7, and the words "open" and "close" with arrows are engraved on the piston rod. By removing the screw securing the adjusting plate the latter can be turned, and with it the valve, to regulate the rate of running up, when necessary.

The *air chamber* (F) is a manganese bronze casting; it is 6 feet 2 inches long, divided into two parts by a diaphragm, the rear part containing the tube (*j*); the front end of the inner chamber has a metal seating for a valve which is screwed into it, and its rear end is closed with a metal plug for charging the chamber. The front end of the chamber is closed by a gunmetal gland and hydraulic packing, secured by a metal flange, which is fixed by screw studs to a metal ring screwed on to the air chamber. To prevent the escape of air over the the gland, liquid is supplied to the gland, which is of H section, by an intensifier, at a higher pressure per square inch than that of the air. A small port admits air, also a small quantity of the 3 quarts of oil in the chamber, into the cylinder of the intensifier. There is an air escape valve on top of air chamber over the main gland, to allow air to escape from the gland when filling the intensifier by funnel.

For charging the air chamber an air pump is connected to one of the oblique channels (*k*), while a pressure gauge registering pounds is applied to the other, and by opening the valve (*l*) of axial channel, air will be admitted to the chamber up to an initial pressure of 250 lb. per square inch.

A small special air pump is attached to the carriage, at the left side under the shell pit shield, for maintaining the internal pressure in the air chamber, and to which it is connected by a pipe when required, air being drawn into the pump from the end opposite to the pipe; the pump is worked by a cross handle.

The *intensifier* (G) is for supplying liquid to the gland, as before stated, and consists of a cylinder cast in the rear division of the air chamber; it has an internal diameter of 5 inches, provided with a piston and rod, stuffing box and gland, all of manganese bronze; the piston is provided with a front and a rear suction leather of L section, which are secured by thin plates and screws, the stroke is about 10 inches. The cylinder will require refilling when the rear of the piston rod is about flush with the rear of the inner gland, but in no case should it be allowed to project so as to foul the shell pit shield; filling is effected by applying a pump to the filling hole, marked "A" on the plug (*see* Care and Preservation, page 68); oil will flow into the cylinder in rear of the piston, the pressure of which will be greater than the air and oil coming through the small port from the air chamber; thus the oil will be forced through a copper pipe from the intensifier on to the air chamber main gland. In the absence of a pump, a funnel and special clamp may be used, the latter for pushing in the piston rod; this clamp consists of two tie-rods, which screw into holes in the rear of air chamber, one on either side of intensifier, a cross-piece to be applied on the piston rod and a compressing screw with lever.

Pressures.—The diaphragm of air chamber will stand a pressure of 500 lb. per square inch when charging with air at 300 lb. per square inch, but the complete air chamber with intensifier will stand a much greater pressure.

Action.—When the buffer and air chamber are charged (*see* Care and Preservation, page 68) before firing, the liquid in the buffer is in front of the piston, and on firing, the cylinder of the buffer is forced into the air chamber; when the liquid passes behind the piston, through the port, the resistance offered by the fluid checks the recoil, assisted by the resistance of the compressed air in the chamber on the cup-shaped end of the cylinder. Air displaced by the advancing cylinder is forced into the rear portion of the chamber through valve and small holes at the centre of the diaphragm, at a pressure about equal to three times that of the initial pressure; this increased pressure, over the normal, acting on the piston of the intensifier through the small port, accelerates the force of the liquid through the pipe on to the gland. The air thus stored up, on complete recoil, pushes the hydraulic buffer cylinder forward, and in doing so brings the gun to the firing position. The controlling ram on entering the hole in the piston rod displaces the liquid received when the cylinder was in the rearward position, the liquid returning through the valve and hole in the ram, the resistance of the liquid on the ram prevents the gun running up too rapidly.

Carriage, Shields, and Sighting Platforms.

(*Plates XVII and XVIII*).

The *carriage* (H) consists of two side brackets, built up of steel plates and angle pieces with cradle trunnion bearings, which are strengthened by a cast steel trunnion bearing riveted on to the outsides; these

castings are provided with phosphor bronze anti-friction trunnion liners and projections for the supporting screws of the ball bearings of the cradle. The sides are connected by having five transoms of steel plates and angles riveted to them. Two bolsters or box transoms are fitted to the underside of the carriage, each one, front and rear, has an upper roller path fitted to its under surface to take a bearing on the live roller ring. The live roller ring (I) consists of two concentric steel rings connected by collar rivets, and furnished with metal bushed axle holes, the axles being secured in the rings; the roller ring carries 16 "Rollers, carriage, No. 18" (I^1) of steel, metal bushed, flanged in front and rear, and coned to suit the pivot. Two plates for connecting the carriage to the pivot are fitted to the carriage, one between the box transoms, the other at right angles riveted together and to the box transoms; there is a hole in the centre, where these plates cross, fitted with a metal bush for the pivot plug. An iron bracket is bolted to the breast transom, to which is secured the front clip plate. The front and rear clip plates (J and K respectively) are of forged steel and bolted to the carriage to engage under the outer flange of the pivot plate.

The carriage is provided with steel capsquares, screwed down, for securing the cradle in its bearings; a removable elevation stop (L), in a metal socket in the right cheek, engages under the cradle side for elevations up to 10°, *see* also page 32; and a bearing (M) for the rear hoist.

Elevation is limited by a wood stop on the rear transoms of carriage and cradle coming in contact, and depression by the front of the cradle and front shield stays in contact, the maximum depression being obtained by the removal of a bolthead from the stay on each side.

A "*carrier, battery box, No.* 9," is secured to the carriage at the left side. Wooden covers are provided to keep out dirt from live roller ring, *see* also page 71.

Shoulder Pieces.—For convenience of the gun layer, a shoulder piece is provided for the auto-sights and for rocking-bar sights; each is made adjustable, horizontally, by means of a steel pintle and clamping lever, the pintle is secured to the carriage. The stock is of walnut wood, with an elastic pad formed of a length of indiarubber tube, which has its upper end protected by a brass cap secured to the stock by screws.

Shields.—Two shields are provided: one for the protection of the shell pit, which also answers the purposes of a platform from which the sighting platforms are reached, loading arrangements, &c., are attended to, while to its underside a circular overhead railway is constructed for the projectile trollies: another, the front shield, is for general protection.

The *circular shield for shell pit* (N) is 21 feet 9 inches diameter, and consists of cantilevers or girders made up of plate and angle steel, supported by knee brackets fixed to the carriage, namely, three on each side and two at the ends; 1¼-inch steel plates are riveted on top of the girders to form the platform. Near the outer rim of the shield is a flange of sufficient depth to admit of the shell trollies running on top of its inside flange, termed the outer rail; an inner rail with a similar flange is fixed to the girders of the shield by knee brackets; the gauge of the rails is 3 feet 5·125 inches. A short length of the inner rail is made removable at the front by being secured with bolts and nuts, instead of rivets, so that the trollies may be removed when required.

A grating is provided on each side in front, and openings in rear for the projectile hoist and loading derrick gears for which there are hinged cover plates or doors *; these hinged doors with flaps must be opened wide before firing at above 10° elevation to allow the gun to recoil free of the shield, and at the same time the pin (L) in the side of the carriage limiting elevation is removed.

The *front shield* (O) is a 6-inch steel plate, made in halves, and fitted together when in position by a steel butt plate and screws on the inside. The shield is winged to the rear and splayed outwards at the bottom; it stands on the shell pit shield, and is secured to the carriage by steel elastic stays with bolts and disc springs. The front is cut away to suit the gun, and also for the sights.

The dimensions are 10 feet 4 inches across the front, and 8 feet at the sides.

The *sighting platform* (P) is erected at each side of the carriage on top of the shell pit shield.

The *trollies* (Q), six in all, are for carrying the projectiles on their sides from the front hoist (R) of the pit to the loading position or rear hoist (S). Each consists of a steel frame mounted on four flanged rollers of 5 inches diameter across the sole, with a clip plate at each end; a wood buffer or striker block, furnished with a rope handle, is bolted on to each side of the frame; a pair of steel hinged bearing straps, secure the shell in transit. In the outer clip plate of the trolley there is a groove to engage two spring catches, which secure the trolley in a position suitable to the hoists, that for the front position is on arm (T), secured to the parapet of the work, and the other to a bracket (U) on the outer rim of the shell pit shield.

The upper part of the mounting is reached by stairs in the "work."

Elevating Gear.

(*Plate XX.*)

This gear admits of 15° elevation and 10° depression, and is so arranged that both can be obtained from either side of the carriage, from the sighting platforms, or by an extension of the gear which is worked from the floor of the pit at the left side, the former being slow-motion gear and the latter quick, *see* Plate for relative power.

The gear generally consists of a powerful cross-shaft (*m*) working in bushes in the carriage sides, and further supported centrally by a steel bracket fixed to the front box transom. This shaft carries two arc pinions (*n*) (each one is secured on the shaft by four keys) which gear with the arcs (*g*) on the cradle, and a steel worm wheel on its outer end at the right side of carriage. The worm wheel is provided with a friction clutch formed of alternate steel and gunmetal rings, eight of each kind, and two jamming plates, the inner being of gunmetal and the outer of steel, all of which fit on the hexagon flats of the shaft. The adjustment of these is effected (to prevent the gun running down when at extreme recoil) by means of a No. 56 spring disc and two steel nuts on the shaft outside of the worm wheel (*see* also Care and Preservation, page 68). The worm wheel just described is in gear with a worm on the second

* The opening between the doors for the rear hoist is now covered by flaps which are opened and closed automatically by the hoist. Guards are fitted to the upper portion of the outer ram to prevent the flaps fouling the tray when being lowered.

motion or worm-shaft (o) working in metal bearings, and to reduce friction as much as possible in these bearings, an anti-friction ring is fitted on each end of the worm, each one consisting of one outer and two inner steel rings, and 23 steel rollers. The worm shaft is in bevel gear with the first-motion spindle which is actuated by the handwheel (o^1).

The *upper* first and second-motion sections of the gear on the left side are similar to those just described for the right side, both these side-gears are connected by a cross-shaft (o^2) having a bevel wheel on each end, gearing with similar pinions on the vertical second-motion shaft. This cross-shaft is supported in metal brackets on the sides of the carriage and on the inside of the breast transom.

The *lower* section of the gear, to be worked from the pit, consists of a bevel pinion on the outer end of the cross-shaft (o^2) just mentioned, for the upper section, motion being transmitted to the pinion by similar gear which is actuated by the handwheel (o^3)

The whole of the elevating gear is suitably supported by means of cast steel and metal brackets secured to the mounting.

Elevation Indicator Gear.

This gear is so constructed that the range required will be indicated on a dial by a pointer. The gear consists of an arc (*h*, *Plate XIX*) which is fixed to the underside of the cradle at the left side, and which is in gear with a spur pinion on a shaft working through a gunmetal supporting bracket in the cheek of the carriage. On the outer end of this bracket is a brass facing plate and a spiral spring, one end of the latter is hooked to a spring barrel on the before-mentioned shaft and the other end to a pin secured to the bracket and to the brass plate by a split key. The object of this spring is to keep the spur pinion up to its work or to prevent back lash. Fitted on the outer end of the shaft is a gunmetal disc, or dial, having a yard scale engraved upon it, the range being indicated by a pointer, which is secured to the rim of the bracket by two screws.

All the parts are made of metal except the shaft, which is of steel.

Traversing Gear.

(*Plate XXI.*)

The upper sections of the traversing gear are arranged to be worked practically from the same positions as the upper sections of the elevating gear, and there is a separate gear to be worked from the pit; like the elevating gear, the lower is quick-motion and the upper slow.

The driving or rack pinion (p) on fourth-motion shaft is at the left front of the mounting, motion is transmitted to this pinion (whose shaft works in metal bushes secured in the box transom of the carriage), by a spurwheel which is in gear with a spur pinion (p^1) on a short third-motion spindle having a spurwheel (p^2) at its upper end in gear with a spur pinion on a vertical second-motion shaft (p^3), at the upper end of which is a bevel wheel in gear with a similar pinion on the first-motion spindle, which is actuated by the handwheel (p^4).

The upper part of the right side gear is similar to that on the left side before described, and is connected to it by a cross-shaft (p^5) in a similar manner to the upper part of the elevating gear.

The section of the gear to be worked from the pit at the left rear of the mounting is similar to that of the third and fourth-motion gears above-mentioned (in second paragraph), and is in bevel gear with a first-motion spindle and handwheel (p^6).

Stops are provided so that practice may be kept within safe lateral limits. These consist of two steel stops which are secured to the pivot plate by screws, and a buffer stop consisting of a spindle with two pairs of disc springs, the spindle is secured to a bracket on the underside of the carriage by a nut and keep pin.

Loading Arrangements.

(*Plates XVII, XVIII, and XXIV.*)

These generally consist of a steel arm with loading tray, derrick, tackle and winch; a front and a rear hydraulic hoist with accumulator gear.

The *cast steel loading arm* is bolted to a projection at the left rear of the cradle, the outer end is prepared for a joint pin upon which the loading tray (V) pivots.

The *tray* is of metal connected to the before-mentioned steel arm by the joint pin, a spring locking bolt being used for securing it in the required position; a steady pin and locking catch are provided to engage in the left face of the bronze end frame of the gun, when loading at elevation. The tray is intended to protect the screw threads in the breech of gun while the projectile is being rammed home; after the cartridge is loaded the projectile tray is swung back and the breech closed.

Derrick, gear, is made of two steel curved plates connected by collar bolts, and secured to a post or pivot piece by screws; the pivot piece is flanged and tapered and provided with two bearing surfaces which fit into corresponding metal bushes in the lugs of two steel brackets at the left rear of the carriage. A "traveller" (consisting of a plate with loop, two flanged rollers, and axle, with collars and split keys) on top of the derrick, to which is attached a tackle consisting of two 5-inch malleable cast iron blocks, the upper treble and the lower double, and a fall of 97 feet, of 2-inch white rope, the running end of which is passed over guide sheaves and down through the pivot piece of the derrick, to a windlass; the latter consists of a cast iron drum with ratchet and pawl, and a spindle with a No. 35 winch handle; it is attached to the underside of the rear box transom of the carriage, immediately below the derrick, by means of a cast iron bracket.

When using the derrick the projectile is brought to the rear of the carriage in a barrow, and then raised from the pit to the loading tray, which is then swung round to the breech of the gun.

Hydraulic, Accumulator Gear.—The *compressors* are fixed in the carriage cradle, and consist of a pair of manganese bronze cylinders (left and right), each cylinder having a stuffing box and gland of the same material, with hydraulic packing and a leather packing ring, L section, the cylinders are connected by a pipe with suitable couplings, air and drain holes with plugs are provided. The compressor rams are of rolled manganese bronze, each is connected to the gun band by a nut and split key.

The compressors with pipes on the carriage belong to the carriage, for the rest of the hydraulic gear, *see* page 39.

The following traversing arc, sighting gear, electric firing gear, hydraulic gear, holdfast, pedestal, pivot plate, pivot plug, telescopes, and carriage cover are used with this carriage; they are *demanded separately*.

Arc, Traversing, No. 34.

Mark I: this arc is of brass made in two ring sections, each being in lengths, the degree figures are engraved upon the upper section, and the division and sub-divisions on the lower one. The arc is fixed on below the flange of the pivot plate. A pointer for indicating the angle of traverse is fixed to the carriage.

Gear, Sighting.

Automatic sighting gear is provided on the right side (except certain sites), and rocking bar on the left; the latter generally for use beyond the effective range of the former.

Automatic Sight, Plate XXII.—The automatic sight is automatically set to the range corresponding to that of the target, by use of a cam action. All that is necessary for use is to align the sight with the target. A correcting gear is connected to the traversing rack to adjust the auto-sight cam with the cradle trunnion axis for any inclination there may be in the pivot.

The gear generally consists of a telescope (*see* page 43) supported in a gunmetal carrier (q), a gunmetal hinge flap (q^1) for carrier, gunmetal bracket supporting hinge flap (q^2), manganese bronze lever cam roller (q^3) with manganese bronze cam roller, cam (q^4), cam sliding block (q^5), cam tidal correction lever (q^6) and graduated arc, and spring in gunmetal case (q^7). The above are supported by a cast steel bracket (q^8) attached to the cradle; this bracket is metal bushed to take the pivot of the cam roller lever, the pivot being allowed 1 degree 30 minutes inclination correction for drift, and is adjusted by a set screw on top of the bracket.

The telescope is secured in the carrier bearings by steel caps which hinge on the left side and kept down by screw clamps on the opposite side; either No. 1 or No. 3 may be used as required (*see* page 43). On top of the carrier is a clinometer plane. Deflection is obtained by the carrier and hinge flap being pivoted near their front ends, there being a traversing rack formed on the rear of the carrier to gear with a worm spindle on the hinge flap; this worm spindle has a drum on its right hand end, the drum has a crown metal deflection scale on its periphery graduated for 2° right and left deflection; a reader to indicate direction, &c., is also provided. The hinge flap is connected to the supporting bracket (q^2), and is given a vertical movement by a joint pin in front and an "error of day" nut arrangement in rear, the nut being clamped by a jamming lever; there is a reader on the rear of the bracket (q^2) to facilitate reading the nut graduations. The bracket (q^2) slides into and is secured on top of the cam roller lever, the latter being pivoted to the steel bracket (q^8) on the cradle; the lower end of this lever carries the cam roller, which is kept up to its work by the steel spring (q^7); one end of the spring spindle is attached to the eccentric spindle of the cam roller, the other end being attached to the carriage. The cam is

of hard phosphor bronze and fixed to the sliding block in the guide (q^5) which is secured to the carriage by screws, the block with cam being actuated as to level of racer by the correcting gear. There is a separate cam for the *full* and *half* * charges, and these cams are substituted by one cut to the range limit of the 1-inch aiming rifle, when required, so as to give increased practice in laying with these sights. Adjustment of the cam for tide level is effected by the lever (q^6) which is connected to the cam, and works on the metal graduated arc, showing rise and fall of tide, the lever being clamped on the arc by a fly nut.

For convenience in laying the gun a shoulder piece is provided (*see* page 31).

For care and preservation, *see* "Regulations for Care and Preservation of War Material, &c."

Rocking-bar Sight, Plate XXIII.—This sight is supported by a manganese bronze bracket (r), secured to the cradle. The principal parts are carrier (r^1), rocking-bar (r^2), sight bar (r^3), with front and rear sights; and a telescope, but which is a separate store (*see* page 42), either No. 1 or No. 3 may be used as required.

The *carrier* is of steel and attached to the supporting bracket by the screw studs (r^4); there is a socket at the rear of the carrier in which is fixed a brass friction spring for the arc of the rocking-bar portion. A metal bracket containing a worm gear is attached to the rear of the carrier; this gear consists of an arc pinion (r^5) having on its spindle a worm wheel (r^6), which is in gear with a worm on another spindle which is set in motion by the handwheel (r^7); on the outer end of the arc pinion spindle is a 6-inch drum (r^8), having on its periphery a yard scale ring, graduated to the full amount of range given in the range table (if possible 11,500 yards) for a full charge, and M.V. 2,040 f.s. The yard scale ring,† for use with half charges, is graduated to agree with the range given in the range table, and M.V. 1,393 f.s. There is also a yard scale ring for use with the aiming rifle. The yard scale rings are of crown metal and the markings are in black, the graduations being read off by the aid of a reader attached to the rear of the carrier.

The *rocking-bar* is connected to the carrier, in front by the pivot pin (r^9), and in rear by the arc (r^{10}); the front end is prepared for the pin of the sight bar; the rear end for the traversing pin or nut, and a cross-head with deflection leaf graduated to 2° left and right, which is worked by a screw with milled heads, 1 degree 30 minutes being allowed as correction for drift; the arc on the underside of the bar is furnished with teeth on the front face to gear with the pinion on the carrier, and in rear a scale graduated to 15°; the sighting is kept rigid by the friction of the worm gear, and the spring in the carrier arc socket, and a stop on the lower end of the arc prevents it running out of gear.

The *sight bar* is a steel tube that carries the sights. The foresights consist of an acorn on a lug of the bar, and a sighting blade on a hexagon at the front of the turning rod within the bar or tube; the rod is secured by a nut and screw, and can be turned down when not required by the thumb piece (k); a spiral spring on the turning rod at the rear, within the tube, retains the sighting blade in position. The rear sight is on a lug secured to the sight bar; it has a 0·06-inch notch.

* Cams for use with half charge and with aiming rifle are not yet settled.
† Yard scale ring for use with half charges not settled.

A *telescope* is provided for use where accuracy is important, or at distant objects, and is carried in two lugs on the sight bar; it is secured by two hinged caps (*see* page 42).

For *shoulder piece*, *see* page 31.

Gear, Electric Firing.

This gear is arranged on the mounting so that the gun can be fired from either side, or from the position finder station; in the latter case a safety plug box with plug are provided, and in order to render the cables interchangeable with guns not position found the safety plug box only is provided (made solid internally).

The gear generally consists of two contact boxes, a pistol grip, safety plug box, two connectors pistol grip, six electric cables, connection cable to battery box, and battery box containing four electric Le Clanché cells with connecting wires.

The *contact boxes* are of gunmetal, and are called "boxes, contact, sliding—Plug and Plate." The Plug No. 2 is of gunmetal, with cap, contact plug in two parts, spiral spring, insulating bush, and washer, releasing lever and flat spring, with two fixing screws (automatic circuit breaker), and is keyed to a gunmetal supporting bracket, No. 7, attached to the gun band, on top. The Plate No. 2 is of gunmetal, with contact plate, insulating bush in two parts and fixing screws (automatic circuit breaker), and is keyed to a supporting bracket, No. 5, attached to the cradle. Contact is made when the gun is run up in the firing position, and the contact boxes are arranged to break the circuit automatically during the recoil, a releasing lever being attached to the plug contact box by which the contact boxes may be approximated when it is required to recomplete the circuit.

The *pistol grip, Mark III*, is the latest approved pattern for this gear. The case is made of a light and tough kind of white metal (Wolframinium), and is fitted with an insulated steel contact needle, an indicator with cover and adjustable reflector, bronze contact lever, bronze trigger, and a system of contacts and springs. The needle end of the pistol grip fits into the connector at either side of the carriage, and is clamped by a screw. The indicator, which acts in a similar way to that of the firing key of the "battery and key test and firing," page 73, is intended to indicate that the electric current is present by a white disc appearing, by lightly pressing the contact lever (which is hinged in a slot in the pistol handle or grip). Contact is made and the tube fired by pulling the trigger of the pistol grip. As this pattern of pistol grip is intended to be taken about to whichever side the gun is to be laid from, care should be taken not to jar or otherwise injure it by rough usage, *and when not in use it should be replaced in its wood packing case.*

The *connectors, pistol grip*, are made to receive the Mark III pistol grip and the electric cables. The connectors fit into a holder on each side of the carriage, and convenient to the gun layer (these positions were previously used for the Mark II pistol grip, left and right respectively). The electric cables hereafter described are attached to the underside of the connectors by screwing in the nuts, the identification letter in each case should agree.

The *safety plug box No.* 1 is of gunmetal, with safety plug, fixing screws, and padlock with key. It is to prevent the gun being

accidently fired owing to there being more than one firing position is to confine the electric current to the required side by the insertion of the safety plug within the box. The box itself is provided with lettered contact holes to receive the nut connections of the cables, and one spare hole which is closed by a mill-head screw and unlettered, and may be used for a tester, or wire from position finder, the second wire from the P.F. being connected to the battery. The box is secured to the left side of the carriage by means of the padlock.

To admit of the same set of cables being used in cases where the gun is not position found the above mentioned safety plug box is provided but without the safety plug, the holes for the plug being plugged up, the box in this case simply acting as a junction box.

The *six M. I electric cables* are copper wire braided with metal split pin terminals (except one end of "A" cable), and connecting nuts; each cable being of suitable length, and having a distinguishing colour, letter and number, the two latter are engraved on the nut connection at the end of each cable, and are filled in with red wax, "A" cable is secured to the fixed frame contact (for "B" lock) on the breech of the gun; the other end of the cable is screwed into the plug contact. The following are the particulars of the cables; those connected to the right-hand side are passed across the breast of the cradle and carriage, and the whole are secured to the gun and mounting by clips with screws :—

Gear, electric fixing—

Cables "A," No. 1—WHITE.—From gun to sliding contact.
13 feet 1 inch long.

"B," No. 1—PURPLE.—From sliding contact to safety plug box, or junction box, for 6-inch and above.
19 feet 7½ inches long.

"C," No. 1—RED.—From right hand pistol grip connector to safety plug box, or junction box.
20 feet 3 inches long.

"D," No. 1—YELLOW.—From right hand pistol grip connector to battery connection.
18 feet 8½ inches long.

"E," No. 1—BLACK.—From left hand pistol grip connector to safety plug box, or junction box.
9 feet long.

"H" No. 1—UNCOLOURED.—From pistol grip connector to battery connection. Left hand for 6-inch and above.
7 feet 6 inches long.

The split pin terminals on the cables should be kept slightly open to ensure good contact.

The "*connection, cable, to battery box No. 7*" is of gunmetal with insulator and contact with gunmetal and ebonite washers; this connection is provided with contact holes to receive the cables of the firing gear, and for completing the connection to the battery box; there is also a spare hole; while for the return current, the connection is provided with a plain socket to fit over a contact stud on the battery box. The connection is secured to the carrier battery box mentioned at page 31.

The *battery box* and *electric battery*. The battery box is secured to the carriage by means of its carrier, page 31, and it is made of No. 11 S.W.G. galvanised steel about 13 inches long, 10 inches deep, and 6·5 inches wide, the handles and fly nuts each project 1·75 inch and 1·5 inch respectively in addition to the above; it is lined with wood, which is saturated with paraffin wax, the wood lining is faced with fearnought to the height of the cells, and three strips of indiarubber are secured along the bottom for the cells to stand upon; two lifting handles are provided. The lid is lined with sheet indiarubber, for the purpose of keeping the interior dry and clean, and wood which is shaped to fit over and steady the cells, all being secured together by glue and brass screws; the lid is secured to the box by a hinged screw and fly nut at each end. On the outside of the box are two metal split contact studs to fit in the sockets of the "connection cable to battery box," before mentioned; the upper contact is secured by copper rivets which pass through the side of the box, lining, and copper strip for connecting to positive pole of the battery, also the necessary ebonite insulating washer on the inside and outside of the box; the lower contact is simply secured to the steel box by copper rivets, for the return current which flows through the steel box to a copper strip, one end of which is riveted to the box, the other end is passed through the wood lining and then secured to the negative pole of the battery.

The battery in present use consists of *four* electric cells, Le Clanché, A, Mark III. The cells are of ebonite, rectangular in shape, 8·75 inches by 5·55 inches by 2·7 inches, 6 block agglomerate; they are issued filled and sealed, and all that should be necessary to set them in action is to fill them three parts full with a saturated solution of sal-ammoniac in water, as described for their care and preservation in the Regulations mentioned hereafter. The cells are put in position in the box, with a felt piece between each one, and then connected up to the copper strips before-mentioned, and each cell in series, *i.e.*, the positive pole of one cell to the negative pole of the next, and so on, by means of a wire, and two mill-headed nuts for each terminal.

The circuit is completed to the side of the carriage required by inserting the safety plug in the correct hole of the safety plug box (where provided), and the gun fired by pulling the trigger of the pistol grip which completes the circuit through the lock to the tube. The return current passes back to the firing battery through the general system of the carriage.

Care and Preservation.—The split contact studs on the box should be kept slightly open to ensure good contact in the sockets of the "connection, cable to battery box." For care and preservation of the cells, *see* page 81, and "Regulations for Care and Preservation of War Material, &c."

Gear, Hydraulic.

(*Plates XVII, XVIII, and XXIV.*)

The hydraulic gear is designed for working the loading hosits, and generally consists of an accumulator, tanks, hoists, valves, pipe connections, pipes and controlling valve gear; also the hydraulic compressors of the carriage. For care and preservation, *see* page 68.

The *accumulator* (W) itself is placed in a chamber convenient to the gun emplacement, and is in connection with the gun mounting and rear hoist by means of pressure and exhaust pipes, which lead through the pivot plug. It mainly consists of the following parts: a cast iron frame with two side cylinders, a main and a pump tank; a manganese bronze centre cylinder, two side rams of gunmetal and a centre ram of manganese bronze; these three rams are made hollow, and each is secured by a taper pin in a steel top block for compressing main springs; four main springs are employed, which are arranged in pairs, one spring of each pair placed vertically over the other; they are enclosed in steel cases and casings, the former being outside and attached to the top block, the latter (casings are provided with a brass ring, each to reduce friction against the cases within) and are attached to an upper plate; the springs in the cases and the block move up and down on four tension rods which are secured to the accumulator frame and to the top plate, each of these rods is provided with a steel collar and nut, stop adjusting collar upon which the top plate rests, and lock nuts; suction, delivery and stop valves, all of which are lettered. The main tank is provided with a cover having a filling hole with strainer and baffle box, the latter is to prevent liquid being forced out through the strainer when escaping from the relief valve; this tank contains a relief and a suction valve. The pump tank contains a double acting pump with an inlet and a bye pass valve, and is connected to the centre cylinder by a pipe, the pump is worked by a lever with cross handle. The centre ram cylinder is secured to the cast iron frame in a recess at the bottom and a steel piece and screws at the top, and is provided with a stuffing box with hydraulic packing, gunmetal gland, and a leather packing ring, L section. The side ram cylinders have each a gunmetal gland with hydraulic packing.

An iron chequered plate (with cover plate, screws and lewis nuts) is provided, for covering in the pit leading to bye pass valve, &c.

Weight of accumulator, about 3½ tons.

The *hoists* are front and rear, each one is connected to a controlling valve by means of a pipe, and each valve to the general system by two pipes (pressure and exhaust), and, when the system is charged with fluid, the hoists are controlled by the valve lever, and directions for raising and lowering are engraved on the valve frame, the lever when set can be secured by a taper pin. The front controlling valve is fixed in the side of the emplacement near the hoist, and the rear one on the top of the shell pit shield; weight of each, 1 cwt. 5 lbs.

The *front hoist* principally consists of a cast iron cylinder with supporting plate, which are embedded in the emplacement, the cylinder contains a gunmetal stuffing box and gland, and hydraulic packing; the ram is of gunmetal, to which is secured a projectile tray. A steel covering plate (with manhole plate, springs and securing screws, with lewis nuts) is provided. This hoist can be worked at any time, so that a projectile may be ready at all times to run over the rear hoist.

Weight, 10½ cwts.

The *rear hoist* is supported in a bearing which is attached to the rear of the carriage; the hoist admits of the gun being loaded at 5° elevation or depression in any position of traverse. It generally consists of a steel cylinder with gunmetal cap and plug, and a steel emptying plug; stuffing box, an inner and an outer gland of gunmetal;

two rams, one inner of gunmetal, the other outer of manganese bronze; a projectile tray of gunmetal is secured to the head of the inner ram by means of a taper pin.

The weight of this hoist is 2½ cwts., but it is included in the weight of the carriage, *see* table, page 21.

The *pipes* on the carriage down to the pivot plug are common to all emplacements, those from the pivot plug to the accumulator (pressure and exhaust) differ according to the position of the accumulator.

The pipes of the controlling valves mainly consist of one from the delivery valve to a three-way connection, from thence one of smaller diameter to each valve, that for the rear hoist has a communication through the centre of pivot plug; two exhaust or return pipes from another three-way connection, that from the rear hoist by a side hole in the pivot plug, then from the three-way connection to the tank.

The telescopic exhaust pipe to the side hole of the pivot plug, from the rear hoist, admits of 132½° traverse right and left of the centre line of front trench; but for carriages having a greater angle of traverse a length of sphincter grip hose is substituted.

Owing to the main springs of the accumulator not fully compressing after each round, the energy of recoil is utilised in recharging the accumulator by means of the compressors on the carriage, thereby saving having to pump, once the system is charged or from loss through leakage. The compressors are charged with liquid from the accumulator by pipes, the pressure passing from the centre cylinder (stop valve), and from the tank (suction valve) through the pivot plug and elbow communication in the left side of the cradle. The return of the liquid on firing the gun is by the same elbow communication and non-return valve to the accumulator.

With this hydraulic gear the projectile is brought in a barrow and laid in the tray of the front hoist (R, Plates XVII and XXIV) in the floor of the pit, then raised to and secured in an overhead trolley (Q), which is run round to the rear hoist (S), to which the projectile is transferred and raised to the loading tray, the latter being swung into the breech chamber before the former is raised.

Holdfast, Carriage Pedestal, No. 4A.

Mark I holdfast is of steel and consists of 13 anchoring plates (S), and 52 holding down bolts which are 9 feet 11 inches long, each having a cotter, the bolts are nutted to the bottom flange of the pedestal and embedded with the anchoring plates in concrete.

Weight, 4 tons 10 cwts.

Pedestal, Carriage, No. 7.

Mark I pedestal (X) is a hollow iron casting, cast in halves and bolted together by means of junction plates and bolts when the pedestal is placed in position. The top and inside surfaces are prepared to take the pivot plate. There are 12 holes cast

vertically through the top and sides with pockets, V^1, at equal distances, for the levelling screws, which are provided so that the pivot plate with racer may be kept perfectly level from time to time. Each vertical hole is fitted with a metal flanged socket, secured by a set screw from within the pedestal, and threaded inside for the levelling screw; each screw is 20·8 inches long, over all, and 4·6 inches diameter, the lower end has a capstan head, and the opposite end a hard bronze bearing plate 0·2 inch thick, fitted on; the top end of the screw fits into a flanged steel nut, having a bearing on the metal socket before mentioned; the nut is 6 inches diameter and 8 inches across the flange, curved on the top to suit the bearing in the pivot plate, and provided with lubricating holes which are connected with those in pivot plate.

The levelling screws are manipulated by applying a tommy or pointed lever in the capstan heads, and then clamped by a screw bolt, having a metal bearing piece screwed on to its point, which passes through a hole in the pedestal and socket from the outside.

The pedestal is secured in the emplacement by the holdfast.

Weight, 17 tons 8 cwts. 1 qr.

Mark II pedestal differs from Mark I in not being provided with levelling screws, an automatic correcting gear being used instead.

Weight, 16 tons 16 cwts.

Plate, Pivot, No. 7, Carriage Pedestal.

The object of this pivot plate is to enable the mounting to be levelled when necessary, owing to uneven settlement of the pedestal, by means of the levelling screws in the pedestal, the bolts by which the plate is secured to the pedestal being loosened for the purpose, and again tightened up when the mounting is truly level.

Mark I is of steel (Y), cast to shape and fitted on top of the pedestal by bolts on either side of racer, there are 30 bolts on the outside and 16 inside of the racer. In the centre of the plate there is a hole having a shoulder to suit the pivot plug. There is a flange on the underside to take a bearing against the inside face of the pedestal, while another flange cast on the outside rim gives a bearing to clip plates of the carriage.

Manholes are cast between the strengthening webs of the plate. In the hollow of the upper side is fitted and bolted the steel racer or lower roller path. On the underside, below the racer, are twelve shallow circular holes, having metal bearing blocks fitted in for the nuts of the levelling screws of the pedestal; each bearing block is provided with lubricating holes and grooves, which terminate in one and lead up to the top of the outer rim of pivot plate by a copper pipe.

A segmental traversing rack is secured above the clip plate flange of the plate by screw bolts.

Weight, 8 tons 12 cwts. (including bolts).

Mark II pivot plate is not fitted for levelling screws, otherwise it is the same as Mark I.

Weight, 8 tons 16 cwts. 1 qr. (including bolts).

Plug, Pivot, No. 19.

Mark I: this is of steel, with securing plate and screws. The plug (Z) has a flange to take a bearing on the shoulder of the hole in pivot plate and in the bush of the carriage. It is prevented from turning by a steel feather let into a feather way. The plug is prepared for the pipes of the hydraulic gear, and is for use with Nos. 4 and 7 pedestal pivot plates.

Weight, 6 cwts.

Telescope, Sighting, { No. 1. (L). ,, 3. (L).

In wood case, for automatic and rocking-bar sights; garrison carriages.

No. 1, Mark I telescope is about 25 inches long, over all; it has an object glass and terrestrial eyepiece; the lenses are of such sizes as will obtain a large field of view with a low magnifying power; the magnification is about 3 diameters, and the field of view is about 10°; hitherto, crosswires and a pointer were provided, the former are now removed, and the latter is primarily designed for night use. There are two gunmetal bearings externally about the centre, each 3½ inches long and 2¼ inches diameter, which allow 3 inches of movement to suit the convenience of different gun layers. A long dew cap is fitted over the object glass end, and is provided with a loose metal cap.

The eyepiece with indiarubber shield, to protect the forehead of the gun layer from shock when firing, screws on to the main tube of the telescope, and is fitted with a broad three-ring milled focussing nut.

No. 1, Mark II differs from Mark I telescope in having improved focussing arrangements. The focussing is effected by turning the eyepiece portion of the tube, the amount of turning movement being read off on a scale numbered 0 to 7, so that individual observers may set their focus to the figure previously determined. The length is 24 inches.

No telescopes of this Mark have been issued with cross-wires, but they are provided with a diamond pointer fixed at the focal length of the object glass.

Weight about 6 lbs. 10 ozs., Mark I; 7 lbs. Mark II.

No. 3, Mark I is generally similar in construction, length and weight to No. 1, Mark II, but is of higher power, *i.e.*, magnification 10, field of view 3½°, and a ∧-shaped pointer.

Full particulars as to care and use of the telescopes are secured to the inside of the lid of the wood cases in which the telescopes are kept when not in use. Ordinary chamois leather is used for cleaning the object glass of the telescopes.

* Cover, Carriage, B.L., 10-inch, Mark IV, Barbette.

This is of waterproofed canvas, formed to protect the upper parts of the carriage and a portion of the gun.

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* The design of cover is not yet settled.

SLIDE, L, BARBETTE, B.L., 10-INCH, "C," MARK I.

(*Plates XI and XIII.*)

The slide is of steel, and consists of two girders, having a slope of 5°; they are connected by front and rear box transoms, the front transom being prepared for the piston rods of the hydraulic buffers; a front transom and a centre beam form the pivot plate; it revolves about a centre pivot. The pivot plate carries a brass bush, which the pivot passes through. The slide is fitted with a live roller ring; traversing gear; retaining gear for holding the carriage in loading position; loading and sighting platform, 5 feet 3 inches long, except those for slides Nos. 3545 and 3546, which are 4 feet 1 inch, fitted with a sighting step on both sides; a swinging loading arm and derrick are provided; the front transom has a bracket furnished with two volute spring buffers on spindles, secured by nut and key.

Clips are fitted on the front transom, which engage a flange on the pivot plate, to prevent the mounting from tipping.

A graduated arc E is let into the floor of the work, and a pointer F is fixed to the front of the slide, by which the angle of traverse is indicated.

Electric Firing Gear.—The "Battery and key test and firing," *see* page 73, is supplied to be placed at G. The battery remains at G, the firing key only being shifted to its bracket at G^1 or G^2 as required.

Roller Ring.

The original front and rear trucks and truck brackets of this slide have been removed, and the front and rear transoms altered and fitted with an upper roller path for the live roller ring, which consists of a plate 4·25 inches deep and 1·85 inches thick, carrying on its outer circumference 36 steel "Rollers, slide, No. 52," on axles, which are put in position in the ring by being placed through from the outside and secured on the inner side of ring by a pin and nut, the inner ends of the axles are of less diameter and threaded to take the securing nuts, a plain portion of the contraction passes through a shoulder bearing in the ring, thus the axles are prevented working inwards. The rollers are coned to suit the pivot and flanged on their inner circumference to keep them on the racer or lower roller path; they are metal-bushed to prevent seizure on the axles.

Traversing Gear.

The traversing gear is fitted in front of the slide; it consists of spur and bevel gear working a vertical shaft upon which is a rack pinion gearing on the inside of a rack on top of pivot block. The gear is actuated by a handwheel (A) at the right front corner of slide and thus the gun is traversed.

Loading Gear.

A swinging loading arm is now provided for slides remaining in approved armaments, to facilitate the service of the gun.

The loading arm and tray are fitted to the left side of the slide at a suitable height for inserting the projectile into the bore of the gun, which must be laid at *three* degrees of elevation for loading.

The loading derrick, formerly in use, is fitted to the slide in a suitable position for lifting the projectile on to the tray of the loading arm.

The loading trays used with the old derrick gear are retained for unloading purposes at drill.

Retaining Gear (for holding the Carriage back in loading position).

An automatic retaining catch is fitted on the right side of the slide for holding the carriage in loading position; it catches against the front edge of the holding-down clip. On lifting the lever, the carriage is released, and will run out. Some carriages have been made with the holding-down clip in two parts; when this is the case care must be taken, when running up, to hold down the running-up lever until the clips have both cleared the catch. In latest manufacture this gear has been discontinued, the gun being loaded in the "run-up" position; but where fitted it will be retained, so long as it remains serviceable.

Pivot and Roller-path.

The pivot block and clip ring are in two heavy castings, which are securely bolted together, and firmly bedded and bolted in concrete. A steel roller-path, and a toothed rack are secured to the upper surface of the pivot block. None of the weight of the mounting is taken by the pivot, the underside of the bush in the pivot plate of the slide being clear of the top of the pivot.

Weight { pivot piece and pin, 9 tons 9 cwts. 2 qrs.
holding-down bolts and anchor plates, 19 cwts. 3 qrs.

SLIDE, L., BARBETTE, B.L., 10-INCH, "D," MARK I.

(*Plates XII and XIII.*)

This slide differs from the Mark I "C" slide in being fitted with two front and two rear trucks to the box transoms, instead of the live roller ring; the position of the pivot and the form of the pivot block, which is provided with a racer for the rear trucks to work upon, the front trucks working on a separate racer; and the traversing gear, which is fitted on both sides of the slide, and consists of spur and bevel gear connected to the front trucks, and actuated by handles shipped on the first-motion spindles of the gear.

SLIDE, L., BARBETTE, B.L., 10-INCH, MARK II.

(*Plates XIV and XV.*)

The slides consists of two girders, having a slope of 4°, connected by five cast steel transoms. Each girder is built up by riveting iron plates on both sides of a top bar of T steel, and a bottom one of T iron.

The front end is supported on a casting of steel (*c*), which forms a transom with brackets (*d*) for the front trucks. The rear end rests on a supporting frame (*e*), which is hinged to the rear transom at (*f*), and to a steel casting at (*g*). The casting (*g*) is formed with brackets for the rear trucks, and is kept on the racer by two channel iron bars (*h*) fixed to a band (*i*) which works in a groove round the pivot block. The stop bracket (*k*) is fixed to the front casting (*c*) and projects downwards in front of the racer, to prevent the trucks leaving the track. Two horizontal rollers are fitted to the rear of the casting (*c*) and four rollers to the front to bear against the racer and reduce the friction when traversing. Two heavy cast iron blocks are fixed to the rear-end of the slide to bring the centre of gravity of the gun and mounting approximately over the top of the pivot. Removable covers are bolted to the castings (*d*) and (*g*) to facilitate the removal of the trucks for cleaning purposes.

On the right side a longitudinal shaft is secured in bearings, a handwheel being fitted at the front end of the shaft for giving motion to the elevating gear on the carriage.

The slide is fitted with front and rear buffer stops (*y*) composed of steel disc-spring; suitable wood platforms at the rear, with ladders (*o*) and hand-rail attached, for loading and firing the gun; and a compound armour shield if required. For pointer, *see traversing gear.*

Electric Firing Gear.—The "Battery and key test and firing," is fitted on the right side, at X^1, and the firing key on hand-rail at X^2 (*see* also page 73).

Traversing Gear.

Traversing is effected by a cross shaft with bevel pinion, transmitting motion from the winch handles (*r*) to a longitudinal shaft fitted with two sprocket pinions on its end. These pinions convey power by two chains to two sprockets wheels keyed on two parallel shafts, which are also fitted with bevel pinions. These pinions actuate bevel wheels on two oblique shafts fitted with spur pinions, which gear into teeth on the trucks (*s*). A pointer is fixed by a metal bracket to the front casting (*c*) to indicate the angle of traverse on a graduated arc let into the concrete.

Loading Derrick.

A derrick (*t*) is attached to the slide for loading at any angle of elevation up to 17°. The projectile is raised by a steel wire rope, which passes over sheaves fitted to the derrick; this rope is wound on a drum at the foot of the derrick, a shaft passes through the drum to take a winch handle; on the same shaft is carried a brake drum con-

nected to the rope drum by a ratchet wheel and pawl. The projectile can be lowered from the loading platform by means of a rod (*u*) attached to a lever (*v*) connected to the strap of the brake drum.

Hydraulic Pivot.

An hydraulic pivot is fitted to take the greater part of the weight off the trucks in order to decrease the work in traversing. It consists of a cylinder and ram fixed on the top of the pivot block. The ram presses upwards against a block fitted into the centre transom; the liquid is passed into the cylinder through the top of the ram by a pipe leading from a pump fitted to the centre transom. This pump has two rams, one arranged to be worked from the hand lever and the other from the winch handle shaft of the traversing gear; the slide is raised by means of the hand lever, and kept up during traversing by the action of the eccentric fitted to the winch handle shaft; however, the eccentric is not now required, as the following packing for the ram has been introduced.

The lift is regulated by links connecting a releasing spindle to the pivot band; this spindle lifts the suction valve when the slide is at the required height, which is shown by a pointer which forms part of the regulating gear. The lifting ram is not provided with packing leathers; but it has a groove cut 0·4 inch deep and 1 inch wide, packed with a mixture of tallow and coarse asbestos fibre, inserted through eight ½ inch holes drilled in the bottom of the ram; any liquid which overflows while the pump is being used runs into a circular tray from which it passes into a tank to which the suction pipe of the pump is coupled. For liquid used, *see* page 67, and Equipment Regulations.

Pivot Block and Racer.

The pivot block is in one casting of iron, formed with a groove for the band (*i*). The top is fitted to take the cylinder for the hydraulic pivot gear, the upper part of this cylinder is made rectangular, and slides in a hole of similar shape in the block fitted to the inside of the centre transom.

The racer is of steel, cast in eight segments, with a hook on its outer circumference, which takes the shock of recoil transmitted through the clip brackets.

	ft.	in.
Height of slide	6	8·46
Length of slide	22	11·25
Height of pivot block	4	10·584

SLIDE, L., BARBETTE, B.L., 10-INCH, MARK III.

(*Plate XVI.*)

The slide which is constructed to traverse on front and rear trucks round a central hydraulic pivot, consists of two girders connected by five transoms, each girder being built up by riveting iron plates on both sides of a top and bottom bar of ⊤ iron, with a steel plate on the top bar.

The front of the slide is supported on a box transom built up of steel plates and angles, and having a cast steel plate on the bottom, with stop brackets projecting downwards in front of the racer to prevent the trucks leaving the track; two horizontal rollers (E) are fitted to the rear of the casting, and four rollers (F) to the front, to bear up against the racer and reduce the friction when traversing. Brackets are fitted inside the box transom for taking the truck axles.

The rear end of the slide is hinged to the cast iron supporting blocks at (C); the supporting blocks are hinged at the bottom to a carriage (H), in which the rear trucks are fitted; and this carriage is kept on the racer by two channel iron bars, fixed to a band (*r*), which works in a groove round the pivot block. The weight of the supporting blocks is augmented by two cast iron counterweight blocks placed on the top of them, in order to bring the centre of gravity of the gun and mounting approximately over the hydraulic pivot.

The slide is fitted with front and rear buffer stops (T), composed of steel disc springs, and with suitable loading platforms at the rear, with ladders and handrail attached.

A pointer (Q) is fixed to the left side of the box transom, to indicate the angle of traverse on a graduated arc let into the concrete floor.

Electric Firing Gear.—Fittings are attached to the slide for a "Battery and key test and firing," the battery being placed at Z and the key at Z′ when required (*see* also page 73).

Traversing Gear.

Traversing is effected as follows:—The first-motion shaft (Y) transmits motion from the winch handle (K) through the second-motion shaft (J) and bevel wheels to the third-motion shaft (L) fitted with a pinion on its lower end; this pinion actuates bevel wheels on the fourth-motion shaft (M), which have upon their front ends the front trucks of the slide.

Loading Derrick.

A derrick (*h*) is attached to the slide for loading at any angle of elevation up to 15°. The projectile is raised by a steel wire rope, which passes over sheaves fitted to the derrick, and is wound on a drum (*i*), worked by a winch handle at the foot of the derrick. The shaft passing through this drum also carries a brake drum (*k*), connected to the rope drum (*i*) by a ratchet wheel and pawls. The projectile can be lowered from the loading platform by means of a rod (*l*) attached to a lever (*m*) connected to the strap (*n*) of the brake drum (*k*). Some slides have been issued with a cartridge derrick in addition.

Hydraulic Pivot, Pivot Block and Racer.

The hydraulic pivot is arranged to take the greater part of the weight off the trucks, in order to decrease the work in traversing. It consists of a cylinder and ram fixed on the top of the pivot block. The ram is pressed upwards against a heavy steel plate (N), fitted between the centre transoms, by the liquid being forced through the pipe (P) and the ram into the cylinder, by a pump fitted to the centre transom. This pump has one plunger, worked from the winch handle shaft of the traversing gear by an eccentric. The eccentric, by means of a hook (gab) on its eccentric rod, can be disconnected from the traversing gear, and worked by the hand lever (*d*). The slide is first raised by means of the lever (*d*), and afterwards kept up during traversing by the action of the eccentric fitted to the winch handle shaft; however, the eccentric is not now required, as the following packing for the ram has been introduced. The lift is regulated by the links (*e*) connecting the releasing spindle to the pivot band; this spindle (*f*) lifts the suction valve when the slide is at the required height, which is shown by a pointer (*g*), which forms part of the regulating gear. The lifting ram is not provided with packing leathers; but it has a groove cut 0·4 inch deep and 1 inch wide, packed with a mixture of tallow and coarse asbestos fibre, inserted through eight ½ inch holes drilled in the bottom of the ram; any liquid which overflows while the pump is being used runs into a circular tray, and passes thence into a tank, from which it is again drawn by the pump. For liquid used, *see* page 67, and Equipment Regulations.

The pivot block is in one casting of iron, and is rigidly connected to the racer by eight cast iron arms; a groove is formed in the pivot block to take the band (*r*), and the top is bored out to take the cylinder for the hydraulic pivot gear. The under part of the metal pivot bush is made square, and slides in a rectangular hole in the centre transom. An angle iron ring in halves rests on the racer arms round the pivot block, to retain the concrete round the recess for the bevel wheels of the traversing gear.

The racer is of steel, in eight segments, and is securely bolted to the outer ends of the supporting arms.

	ft.	in.
Height of slide	5	6
Length of slide	22	5·155
Height of pivot block	5	11·25

CARRIAGE, GARRISON, DISAPPEARING, B.L., 10-INCH MARK I.

(Plates XXV to XXXI.)

The principal parts of the carriage are :—

1. The lower carriage, which is placed in the second pit, with its circular top surface level with the floor of the gun pit. (B, Plates XXV

and XXVI.) For facility of transportation this piece divides into four pieces, namely: the front piece, which weighs about 5 tons; the rear piece, which weighs about 2¼ tons; the two side pieces, weighing each about 1¼ tons.

2. The main girders, which span the lower carriage, carrying the recoil cylinder between them. (B¹, Plate XXV.) These weigh each about 1½ tons.

3. The rocking carriage or elevator, with the crosshead, which is made up into one piece, weighing about 4¼ tons. (A, Plate XXV, and K, Plate XXVII.)

4. The recoil cylinder and ram together make the heaviest piece, and weigh 6½ tons. (H and J, Plate XXVII.)

5. The live rollers, which are held in place by the live roller ring, and run between the upper and lower roller paths. (W, Plate XXV.)

6. The rack fixed to the lower roller path, with the traversing gear working into it, and carried on the circular lower carriage.

7. The elevating gear. (Fig. 2, Plate XXVII.)

8. The carriage is also provided with a large overhead shield, somewhat less in diameter than the mouth of the gun pit, and of a thickness of 1 inch. (C, Plates XXV and XXVI.)

This shield is stiffened on the underside by plate and angle beams, and is supported from the lower carriage by eight pillars, constructed of angle bars. (C¹, Plates XXV and XXVI.)

For facility of transport and erection, the shield is made up into four pieces, each weighing about 5½ tons.

Besides the above there are many minor fittings, such as :—

(*a*) Sights on the shield for approximately laying the gun before it is raised above ground, but these are being replaced by carriage sights. (F¹ and *d* respectively, Plate XXV.)

(*b*) A pump on the recoil cylinder, for getting the gun down without firing it. (S, Plate XXVII.)

(*c*) A set of handrails, under the shield, along by the chase of the gun, to prevent men from standing where the gun might strike them, if fired. (C², Plate XXV.)

(*d*) A set of cut-off gear, acting upon the lever which controls the motion of the gun raising valve, to bring the gun gently to a stop at the firing position. (T¹, Plate XXVII.)

(*e*) Securing gear, to lock the gun down. (XX, Plate XXVII.)

(*f*) Ladders to reach the top of the shield.

(*g*) Hinged platform, for obtaining a standing position behind the gun sights; these being made to spring clear of the gun after use.

(*h*) Indicator, and direction plates, as guides in working the carriage.

(*i*) Electric firing gear.

Lower Carriage.

(*Plates XXV and XXVI.*)

The lower carriage, with its main girders, is constructed of mild steel plates and angles. It has no actual centre pivot but is held in place, so as to revolve about its centre, by double flanged live rollers,

which take on the upper and lower roller paths (Y); and by the front and rear clips, which prevent more than a trifling lift from taking place when the gun is fired. There are five front clips (E), and three rear clips made of cast steel, of a form to hook under a rim formed for the purpose on the lower roller path; they are each secured to the lower carriage by 13 large bolts. The carriage is fitted with sockets and footsteps for the shield pillars, and at its front end with the brackets for the pivot of the elevator. To keep the recoil within safe limits, a series of disc springs are fitted on the buffer stops, which also have a dead stop to take the weight on the springs being compressed.

Between the circular girder at each side and the main girders there is room for the numbers employed in traversing and elevating the gun, and a chequered footplate is provided for them to stand on, about 2½ feet below the level of the floor of the gun pit.

Suitable fittings are provided for the firing gear, *see* "Electric Firing Gear," pages 54 and 73, and "Sighting Gear," *see* page 57.

Elevator Carriage.

(*Plate XXV.*)

The elevator or rocking carriage consists of two cast steel beams of curved form, united together, wherever there is space clear of the gun, by cross transoms. At the top they are formed into bearings for the gun trunnions, and are fitted with capsquares. These capsquares slide into place from the outside, and are secured there by dog-tailed pins, made with a spring and key to prevent them from being shaken out. The arms of the recoil ram crosshead pass through bushed holes near the centre of the elevator; these bearings are prevented from turning in their seatings by three small screws, which are inserted between each bearing and seating. This crosshead, therefore, cannot be taken out when the beams and cross transoms of the elevator are once riveted up. At the bottom the beams of the elevator have bushed holes for the pins on which it pivots when the gun goes up or down.

With a view to avoiding the possibility of the gun being fired before it is fully "up" in the firing position, the rear web of "elevator" is fitted with an arrow plate and "bracket, pin, joint, elevator," with a pointer in such a position as will clearly indicate when the pointer and arrow coincide that the gun is in the correct firing position.

Recoil Cylinder.

(*Plates* XXVII to XXX.)

The recoil cylinder is bored out from a solid ingot of mild forged steel. This method of construction is adopted to get rid of the uncertainty attendant upon the manufacture and employment of a casting, but it has also the great advantage that the compressed air used for counterbalancing the weight of the gun is contained in about a dozen chambers in place of one, so that if the cylinder were torn open by being struck in action, the compressed air would escape only slowly and without explosive effect. The cylinder is screwed into a

cast steel trunnion ring, the trunnions of which are supported in brackets fixed to the main girders of the lower carriage. The centre of the cylinder is bored out for taking the recoil ram, and is fitted at the top with a cylinder cover. (R, Fig. 1, Plate XXVII.) To prevent the ram from coming out of the cylinder at the end of its stroke, it is provided with a divided piston, and there is also a divided internal collar at the top end of the cylinder. The lands and grooves thus formed allow the ram to pass in or out, but when partially turned round the ram is locked, and prevented from coming out again. From the inner cylinder to the air chambers passages are cut, and these are fitted with six recoil valves, which permit liquid to pass from the inner cylinder to the air chambers, but not to pass back again. These recoil valves can be reached by removing the end plugs. (M, Plate XXVII.)

A draw-off valve with a flexible tube is fitted to the lowest plug of the air chamber to facilitate the drawing off of the liquid when necessary.

For the liquid to pass back again when the gun has to be raised, a raising valve is provided at L, and this is opened by a rack and pinion moved by the rod T and hand lever D. It is shut automatically as the gun rises by a slotted-link rod attached to the rocking carriage, which also acts upon the rack and pinion through the rod T. Near the middle of the cylinder, on the top side, is a filling cock (N) and a liquid level cock (P), which is now made in two parts. An air valve, giving a vent to the inner cylinder, is fitted at the top of the cylinder at Q.

The recoil ram is made of manganese bronze. It is fitted at the top with a spring draw buffer. (*See* Fig. 1, Plate XXVII.) This is made up of 15 dished spring washers (KK), and the draw-bolt (JJ), which connects the crosshead to the ram. This arrangement allows the crosshead to be drawn off the ram about $2\frac{1}{2}$ inches, against the action of the spring, if it should happen that the gun rises too violently into the firing position.

Adjustment of Recoil Valves to suit Powder or Cordite Charges.—In the case of guns equipped with cordite cartridges and which fire powder charges at practice, *precaution must be taken to prevent guns from being fired with powder charges when the recoil valves are set for cordite. On completion of firing with powder charges the recoil valves will be at once re-set for cordite.* *See* also Care and Preservation, page 72.

Live Roller Ring.

The live rollers are carefully coned to suit the circle round which they travel, and being all of the same size, they have therefore no tendency to get out of place; nevertheless, it is considered safer to hold them in place by a live roller ring, which consists of two concentric steel rings connected by collar rivets; and furnished with metal-bushed holes for the axles of the rollers; it carries 20 "Rollers, carriage, No. 10," which are flanged and bushed with gunmetal to prevent their rusting fast to the axles. The only weight which comes on the axle pins is that of the live roller ring.

The advantages of mounting the carriages on live rollers in place of an actual pivot are, first, that the shifting of the gun from one position to the other does not alter the amount of work to be done in traversing the gun; and, second, that with properly made roller paths

and rollers the work of traversing is extremely small, a force of only about 8 or 10 pounds being required for each ton of weight moved. Thus, in the present case, the revolving weight of gun carriage and shield is, say, 82 tons, so that the application of a horizontal force of, say, 800 pounds at the radius of the roller path will produce motion.

Rack and Traversing Gear.

The rack fixed to the lower path is of steel, in short lengths. The teeth are placed vertically, so as not to get choked with dirt. There are 270 teeth in the complete circle, that is, each tooth is a degree and one-third.

The rest of the gear used for traversing the gun is carried on, and therefore revolves with, the lower carriage. On each side is a pinion with 12 teeth gearing into the traversing rack, and driven through the third-motion shaft by a spur wheel which has 54 teeth. Into this spur wheel a pinion of 12 teeth on the second-motion shaft is geared. The second-motion shaft is driven from a bevel wheel and bevel pinion of 40 and 14 teeth respectively, contained in the box guard, on the top of the lower carriage. The first-motion shaft, on which the last pinion is fixed, has a 3-feet hand wheel (WW, Plate XXVI), with a crank handle keyed to it. For traversing a short distance it will be found most convenient to haul on the top of the rim of the hand wheel, but for a long distance the crank handle is more easily worked. The speed of travel of the rim of the hand wheel is 69 times that of the carriage at the radius of the roller path, so that the power to be applied at the rim of the handwheel is $\frac{1}{69}$th of the 800 referred to above, that is to say, about 12 pounds. There is an indicator plate marked "right" and "left," meaning "trail" to the right or left.

A pointer is fixed to the circular portion of the lower carriage at each side, to indicate the degrees of traverse, which are engraved on a traversing arc laid in the emplacement; this arc is in three circular divisions: the inner is graduated into degrees and subdivided into half and quarter degrees; the outer circles have the figures or numbers engraved on them; each set of numbers begins and runs round opposite to each other.

Elevating Gear.

The elevating gear gives elevation or depression to the gun by means of two long rods (AA, *see* Plates XXV and XXVI), which are pivoted at their upper ends to an elevating band tightened on the breech end of the gun, and are hinged at their lower ends to the toothed elevating arcs (BB, Fig. 2, Plate XXVII), actuated by a train of toothed gear and hand wheels fitted to the carriage. This gear has an elevating shaft (YY), provided with an automatic regulating brake (EE), for the following reasons:—

When the gun is in the firing position, and it is necessary for the purpose of laying on an object to depress it, the elevating rods (weighing about 660 lbs.) have to be lifted by the elevating gear; but if the gun has to be elevated, the weight of these arms is sufficient to make the gear run away when once put into motion. This is compensated for by the brake, which is made with a friction pawl, which grips the drum (NN) when the gear revolves in the direction required for elevating the gun, so as to turn the drum on its cone, and set up enough friction to

more than counteract the weight of the arms (AA). When, however the gear is turned in the opposite direction, the pawl slides freely over the drum, so as to avoid turning the brake. The springs (JJ) should be adjusted to hold the drum and cone together till the friction produced is the right amount. This may be very fairly judged by making the power required on the hand wheel for elevating the gun the same as that for depressing it.

The main elevating shaft (CC) is not rigidly keyed to the cog wheel (LL), but is driven by friction plates of alternate steel and bronze (MM). These plates should be tightened into the wheel by the spring (GG) and the nut (HH) sufficiently to insure that the cog wheel will not slip round without moving the shaft (CC) under ordinary circumstances, but that it shall so slip whenever the shaft is jerked violently round when the gun is fired. This frictional driving apparatus is introduced to prevent the teeth of the wheels from being over strained. It is of importance that the spring (GG) should be properly tightened. This can be detected by fixing the shafting (CC) so that it cannot revolve, and by then hanging a weight of about 95 lbs. on each hand wheel at a radius of about 12½ inches from the centre. This weight should just cause the gear to slip.

The range of elevation and depression at which the gun can be fired is from 15° elevation to 5° depression, and the elevating arc guide on one side of the carriage is graduated to this extent in degree markings, and is inscribed "not to be fired beyond this mark" at each end. The elevating arcs have a long range of travel, because when the gun is fired it is necessary to let them follow the movement of the gun. The arc guides are fitted with spring buffers to check the movement of the arcs if they run up too violently.

A yard scale plate, graduated for yards of range, is fitted to the outside of the elevating arc guide, the range being indicated by means of a steel pointer attached to the elevating arc.

Loading Gear.

(*Plate XXV.*)

An improved loading gear is now provided to facilitate the service of the gun.

The gear consists of a radial arm (A^1) with a loading tray (A^2), pivoted to a post which is suspended from the shield. The height of the tray can be adjusted to meet varying lengths of recoil, by means of a screw fixed to the post, and actuated by a hand wheel and bevel gear.

The loading tackle with shackle in previous use have been removed from the old position at the rear of the shield, and fixed to the shield in a position suitable for lifting the projectile on to the tray.

The loading trays in previous use are retained for unloading purposes at drill.

Electric Safety Firing Arrangements.

(*Plate XXV.*)

Electric-firing gear, which can be operated from either the emplacement or the position-finder, is provided. The circuit is completed by attaching the wires of the tube to the terminals, (d^2), on the breech of the gun (*see* firing mechanism, page 10), from whence two cables, D 13,

are conducted along the gun and down the elevator, as at (f^2,f^2), across the end of the elevator pin, to the electric battery on the lower carriage; and cables are arranged from the electric battery to the firing key bracket at carriage sight manhole, and to the P.F. safety firing plug.

To prevent accidents by premature firing, one of the wires above mentioned is divided at (h^2), and fitted with rubbing contacts, which automatically complete the circuit by coming in contact only when the gun is in the correct position for firing.

The leads from the terminal on the breech of the gun, down the elevator, and along the underside of the flange of the lower carriage, are of "Cable electric, D 13," instead of D 9 as formerly. The leads are retained in position by means of adapters fitted to the retaining nuts of the brackets and supporting double clips with fixing screws, *see* page 79.

To prevent the electric firing cables near the breech of the gun becoming chafed by the breech cover, a steel cable protector is now fitted over the cables, and secured by the fixing screw of the rear cable clip on the gun.

Shields.

The overhead shield is intended to keep out fragments of shell bursting overhead; it also makes a very good roof. When the carriage is mounted in closed circular pits, sliding cover plates are provided for closing the emplacement against intruders. In hot climates the shield may be covered with a non-conductive material to keep the gun pit cool. It may be used for a look-out platform. A sighting platform, furnished with handrail, having if necessary a bracket for firing key attached to it, as shown in Plate XXV, is fitted on rear top of shield, to enable the layer to lay the gun by means of the service sights. There were formerly two ports through the shield for sighting purposes, but the shield between these ports is now cut away and a sighting platform, with ladder, are provided.

A bracket or else a tray is secured to the carriage at the right rear (Z), for supporting the "battery and key test and firing"; to this bracket or tray are fixed binding screws, to which any leads not electrically in use may be temporarily attached out of the way.

For description of the electric battery used and arrangement of leads, &c., *see* page 73.

A shield,* protecting gun layer when laying by rocking-bar type of carriage sights (page 57), is fixed to the top of the main shield; to this protecting shield a bracket for firing key is fixed (P, Plate XXVIA).

A guide roller is fitted to the rear of the shield to give a direct lead to the firing lanyard, excepting when the gun is fired from the top of shield.

Of the minor fittings of the carriage, the following is a description:—

Pump.

The gunmetal pump (S, Plate XXVII) on the back of the recoil cylinder is a double-acting force-pump, that is to say, it makes a

* This shield is not yet settled, but in the meantime the firing key bracket will be fixed in a position convenient to the gun layer.

suction and delivery with both the up and down strokes. It has two suction and two delivery valves fitted with small phosphor-bronze springs to help them to shut, and is worked by a lever (SS) with a cross handle. The pump is fixed to the recoil cylinder because the cylinder oscillates on its trunnions when the gun rises and falls; otherwise it would be necessary to connect the pump to the recoil cylinder by flexible suction and delivery pipes. The pump has a constant stroke of 4 inches, but to obtain this under the varying positions it is thrown into by the oscillations of the cylinder, it is necessary to make the pump longer by 2 inches, or the amount of the oscillation. The pump transfers the liquid from the inner cylinder to the air chamber of the recoil press. The weight of the gun assists this action, so that the work of the pump is only to reduce the pressure under the recoil ram till the gun can descend by its own weight. Stopvalves are fitted to the suction and delivery pipes, to enable repairs to be executed to the pump without blowing off the pressure from the cylinder. The stopvalve for the suction pipe will be also used to release the air which sometimes accumulates in the top of the ram chamber and interferes with the action of the pump.

Cut-off Gear.

The cut-off gear (T^1 and T, Plate XXVII) is provided in order to make sure that the raising valve gets moved towards the closed position as the gun nears the firing position, so that the gun's speed may be gradually checked. The cut-off is not intended to entirely close the valve, although the chain may be screwed up short enough to make it do so, but this is not recommended, as it involves loss of time, the speed being so extremely slow towards the last. The valve is intended to be finally closed by hand, and may with care be entirely so worked if the cut-off gear happens to be damaged or out of order. The chain of the cut-off gear is attached to the cross head and to the elevator; these points are so chosen that if the buffer in the cross head comes into action, the cut-off chain is not drawn tighter by the extra forward movement of the gun, because the part attached to the cross head slackens as much as the part attached to the carriage is overdrawn. There is a right and left hand coupling to the cut-off chain for the adjustment of the length, and check nuts to fix it when adjusted.

The chains of this gear will, in the event of the existing gear being found to fail, be replaced by a rod with slotted link.

Securing Gear.

The securing gear (XX, Plate XXVII) is fitted for holding the gun down, so that the carriage may be left without fear of the gun rising, which might happen either from the valve being left partially open, or from interference with the hand lever by unauthorised persons. It consists of a pair of hooks which are hinged to the main girders of the lower carriage, and can be hooked over the flanges of the beams of the elevator. These hooks are made with a set screw at the top, the point of which can be screwed into a shallow hole in the flange of the beam of the elevator, so that when put in place they cannot well be undone without a spanner of the right size. When in use both hooks are intended to be used at the same time.

The following sighting gear is used with this carriage, and is demanded separately:—

GEAR, SIGHTING. (*Demanded separately.*)

Originally hydro-pneumatic carriages were fitted with rough shield sights, so that direction might be maintained during loading, the gun, when up in the firing position, being correctly laid by the ordinary sights of the gun. These gave place to fittings on the shield prepared to take the spare fore and tangent sights. Now carriage sights of the rocking-bar type are approved for this class of carriage remaining in approved armaments; as this system is not affected by the recoil on firing, the sights can be adjusted to the required elevation and deflection and kept aligned on the object during loading, thereby facilitating the rate of fire.

The following is a description of the rocking-bar type of sights, but if necessary guns may be laid by the ordinary sights in the gun from the sighting platform on the top of the shield at the rear (*see* shield, page 55):—

Gear, Sighting (*Plates XXV and XXVIA*).—This gear is at the left side of the carriage, and generally consists of a steel pedestal (*a*), bracket and adjusting slide (*b*), hinge-stud (*c*), frame (*d*), sockets (*e*, *f*), for the fore and tangent sights, telescope, and connecting rod (*g*, Plate XXV).

The pedestal for supporting the gear is secured on the front transom of the carriage. On top of the pedestal is a cast steel bracket and adjusting-slide with stud for the sight-frame; to the latter is riveted a lever (*h*), which is hinged to the connecting rod, and the lower end of this connecting rod is pivoted to the elevating arc of the carriage, and on the same pivot-pin as the gun elevating rod of that side. By this means the sight-frame is actuated automatically as the gun is elevated or depressed only, but not on recoil.

The gun fore and tangent sights fit into the top of the sockets (*e f*), and laying by them (elevation and deflection) is carried out in the ordinary way.

A telescope, the same as for Mark IV barbette carriages (page 43), is provided for use when great accuracy is required or when laying on indistinct objects, also a small acorn-point fore-sight and a notch hind-sight are furnished on the bearings of the telescope at one side. The telescope is supported in the usual holders in a gunmetal carrier (*i*), flap (*j*), and link (*k*) on the arm (*l*) at the top of the rear pillar (*o*). Elevation is given to this telescope sight by a range drum (*m*), which is connected to the hinged-flap (*j*) and link (*k*); this drum consists of an inner and outer case, the inner one is graduated spirally in yards of range, and an indicating arrow is engraved on the other. A rack at the rear of the telescope carrier admits of the latter being traversed 2° right and left for deflection, by means of a worm on the spindle of the deflection drum (*n*), the drum being fitted with a metal scale-ring accordingly, and a reader point for indicating the deflection on the drum is attached to the rear of the flap (*j*).

For shield protecting gun layer (*p*) and firing key bracket, *see* "Shields," page 55.

CARRIAGE, GARRISON, DISAPPEARING, B.L., 10-INCH, MARK Ia.

(*Plate XXXII.*)

This carriage is a modification of Mark I disappearing carriage. It differs from the latter principally in being fitted with an elevator crank, hydraulic buffer, lowering pump, and retaining gear, instead of the H.P. cylinder gear.

Elevator Crank.

This is a steel casting formed to fit in between the curved beams of the elevator carriage, and is formed into two sides or arc segments, cross-heads, and centre transom, with central strengthening plate between cross-head and transom. The cross-head is provided with trunnions which fit into the old bearings of the cross-head of H.P. cylinder; the centre transom is bored out and bushed for the elevator joint pin, which passes through it; racks are formed on the lower surface of the side which gear with the spur pinions of retaining gear; the rear of the side is prepared for the links connecting the crank to cap of hydraulic buffer cylinder; a bracket is bolted on the outside of each side for the front buffer stops, each stop consisting of 10 disc springs, spindle, with collar and nut.

Hydraulic Buffer, Air Chamber, Lowering Pump, &c.

The buffer and air chamber are secured horizontally between the main girders of the lower carriage; the principal parts are:—Cylinder (A), piston, piston rod with plunger; air chamber (B); intensifier (C); and pump (D).

Buffer Cylinder.—This forms also the ram of the air chamber. It is of forged steel, furnished with two metal valve keys, which fit into ports in the piston head and regulate the pressure of the liquid as the gun recoils. The rear end is prepared for a cap, which is screwed on, the joint being closed by a copper ring, the joint in front of the cap being closed by two leather rings and a manganese bronze ring let into a recess in front; this ring is secured by another ring of steel placed over it, and attached to the cap by 16 screws; the rear of the cap carries the metal gland of piston rod, which is secured to the cap by 8 screws passed through the flange of the gland; hydraulic packing is used in this gland; trunnions are formed on the cap for the links connecting elevator crank. The front end is solid, and carries the controlling plunger. A filling hole is provided on top of the cylinder, and an emptying one underneath.

The Piston.—This is formed on the front end of piston rod; a phosphor-bronze valve ring is fitted in rear of head to prevent scoring; the ring is secured by a nut screwed on behind it, and fixed by a metal pin. The head is furnished with two ports, fitted for the valve keys in the cylinder.

The Piston Rod.—This is secured to rear of carriage. It is bored out along ths centre, to admit the controlling plunger in front, and the flow of liquid from ths raising and lowering valve in rear. The

valve "raising and lowering" (E) is screwed into the rear end of the piston rod; each valve is furnished with an indicator and a handle for turning to "shut" or "open." It has also two connections, one for delivery pipe (F) and one (G) connecting valve to tank.

The Plunger.—This is of manganese bronze, screwed into the fore end of the cylinder opposite its channel in piston rod; its object is to control running up; it is bored out along the centre for the passage of liquid, which is regulated by a phosphor-bronze valve in the point; liquid is admitted by a radial hole near the point, and allowed to escape by radial holes near the base.

The Air Chamber.—This is of manganese bronze, the cylinder of the buffer acting as a ram; a metal gland is secured to the rear of the chamber by 10 screws; the gland is supplied with liquid in the first place through a small filling hole on top of chamber, and afterwards from the intensifier at a higher pressure per square inch than the air in the chamber. For charging the chamber a filling valve, provided with a handle, is screwed into a hole in front of chamber; the valve has an arm for the pipe of the air pump.

The Intensifier.—This is for supplying liquid to the ram gland of air chamber by means of a copper pipe (H). It is placed under the air chamber (B), the supply having to be intensified so as to overcome the pressure of air which might escape through the gland; it consists of a cylinder piston, which is furnished with packing rings, front and rear, secured by screws, and a metal stuffing box for piston rod; the rod has a cross-head to take an indicator-lever, which pivots on a bracket (I) secured to the lower carriage, and by an index plate, which shows whether the cylinder is "full" or "empty," &c.; if the latter, liquid is pumped into it through the pipe (J) from the lowering pump through a suitable cut-off valve.

The Lowering Pump.—The pump is secured to the carriage under the buffer. It principally consists of a cylinder and plunger, with the necessary metal stuffing boxes and glands with packing; the lower end of the cylinder is closed by a gunmetal cap, and the plunger in the upper end is connected to a guide rod, supported in brackets and bearings, and actuated by the lever (K). It is used for pumping the gun down when required, and for charging the intensifier when necessary. It is connected to the raising and lowering valve of piston rod by the delivery pipe (F), and to an iron tank (L), on rear transom of carriage, by the suction pipe (M).

Raising Gear.

This gear is in front of lower carriage; a clutch shaft, working in brackets secured to the carriage, carries two spur pinions in gear with the elevator racks; a powerful clutch is fitted on the end of shaft, right side, which is made up of a steel spiral spring on the clutch shaft, between thrust bracket and clutch, two clutches whose engaging surfaces are furnished with teeth, one fitted with featherways and keyed to the clutch shaft, but free to move along it; the other bushed and carrying over it 30 friction plates, metal and steel alternating; these are compressed by a steel friction block in a metal cover; to the cover is fitted a compressor screw, actuated by the compressor lever (N), which, when tightened, bears against an antifriction stud in the friction block, thus engaging the toothed clutches. A striker (O), which

engages a lug on the right front buffer stop, is actuated by the weight of the compressor lever through the shaft (P) on bracket and automatic tightening lever (Q).

Action of Gears.

Before firing, the raising valve in piston rod must be opened and the lowering valve closed. The liquid in the buffer cylinder is behind the piston; on firing the gun the cylinder is pulled forward with the crank elevator, the liquid passing through the ports to the front of the piston, the space taken up by piston rod being replaced with liquid drawn from the tank through raising valve and piston rod; the cylinder in its forward movement compresses the air in the chamber (the air being required to return the gun to the firing position); compression is put on by the lever (N, Plate) of retaining gear falling over to the front, and with the weight of the lever the gun is retained in the down position on the rear buffer stops of carriage.

To Raise the Gun.—Open the raising and close the lowering valve; take off the compression by lifting the lever of retaining gear till approximately vertical; the compressed air in the chamber forces the buffer cylinder back with the elevator crank, the liquid in front of piston being forced through the central hole in piston rod, raising valve, and pipe from valve to tank into the tank; when the gun is nearly up, the plunger enters the hole in piston rod, the liquid in it resisting the passage of the plunger, and assists in bringing the gun to rest in the firing position; the automatic lever, coming in contact with the compressor lever, sets up friction by moving the latter forward automatically and causing the striker to engage the lug of front stop, thus bringing the gun gradually to rest and retaining it in the up position.

To Pump Gun Down.—Close the raising and open the lowering valve by turning the lever handles in the direction indicated, also open tank cock (R); work the lever of lowering pump, by which means liquid will be drawn from the tank and passed through the pump, lowering valve and centre of piston rod into the cylinder of hydraulic buffer, causing the cylinder to move forward similarly as if the gun had been fired; when the gun is down, open raising and close lowering valve, and close tank cock.

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*CARRIAGE, GARRISON, DISAPPEARING, B.L., 10-INCH, MARK II.

(*Plates XXXIII and XXXIV.*)

Lower Carriage.

The body of the carriage or lower carriage consists of a pair of steel beams connected together so as to form a solid frame (A). Towards the middle of the lower side of the frame is a pivot plate fitted on to a pivot piece (B), securely bedded in the masonry or concrete of the emplacement.

* Originally called Easton and Anderson (E and A) Mounting.

The outer ends of the lower carriage are carried on two pairs of cast iron wheels or rollers (C), travelling on a roller path embedded in the floor of the emplacement. And to facilitate the service of the mounting, the under side of the lower carriage, front and rear, is furnished with an upper roller path for a live roller ring (C^1) generally similar to that for the Mark I disappearing carriage. There is a lower roller path for live ring, rack, and traversing gear.

Elevator Carriage, Recoil Cylinder, Buffer.

On the upper side of the frame towards the middle are secured a pair of cast steel pedestals (D), which carry a steel rocking shaft (E), on to which are shrunk a pair of bent wrought iron elevators (F), the upper ends of which are formed into bearings for the trunnions of the gun, and fitted with capsquares.

The lower ends of the elevators are connected by a wrought iron shaft (G), round the middle of which is clasped the outer end of a connecting rod, the opposite end of which abuts into a recess in the bottom of a hollow trunk or plunger, which works into the horizontal recoil cylinder, through a gland packed either with leather or hemp packing.

The plunger is a little smaller in diameter than the cylinder, but terminates in an enlargement or piston which fits the bore, and serves at once as a guide, an automatic throttle valve, and a stop to prevent the ram being forced out too far.

The cylinder is of cast steel, and is secured to the side girders of the main frame.

On the rear end and top of the cylinder are two automatic recoil valves, which communicate by means of the pipes with two steel plate air vessels (K), placed horizontally one on each side of and over the cylinder.

When the gun recoils the connecting rod and the plunger are forced into the cylinder; and the liquid with which the cylinder is filled is driven through the recoil valves into the air vessels, compressing the air contained in the latter. The valves being "non-return," the liquid cannot return through them to the cylinder.

NOTE.—*The letters* (F^2), *and* (M^2), *represent the parts designated by* F, *and* M, *when the gun has recoiled into the loading position.*

Leading from the lower sides of the air vessels to the recoil cylinder is a pipe controlled by a screw stop valve, and on opening this valve (the gun having recoiled and the air in the vessels being compressed) the liquid in the air vessels is forced back by the compressed air into the cylinder, driving out the plunger and connecting rod before it, and thus by means of the elevators elevating the gun into the firing position. As the gun nears the firing position, a port, which controls the passage of the liquid into the cylinder, slowly closes, and the gun is brought gently to rest.

Buffers are provided to check the gun both in its downward and upward movement.

Elevating Gear.

The elevating arrangement consists of an elevating band secured to the breech end of the gun, to which are attached a pair of elevating rods (M), the lower ends of which are attached by elastic connections to a shaft which crosses from side to side of the frame, the ends of which

are fitted into racks (N) working into guides secured to the inner faces of the girders forming the frames. The racks are elevated by gearing, and the two racks are worked simultaneously by spur wheels actuated by hand wheels (O) on either side of the carriage. A friction clutch is introduced so as to avoid sudden shocks to the gear.

A yard scale plate, graduated for yards of range, is fitted on the outside of the elevating arc guide, the range being indicated by means of a pointer.

Traversing Gear.

This consists of a system of shafts, spur and bevel gear, and is actuated by the handles (P) on each side of the carriage.

Sighting Platform, and Carriage Sights.

The sighting platform (X), with step ladder and handrail, are fitted to the left side of the carriage.

For sighting gear, *see* page 63.

Loading Gear.

The projectile is brought up on a barrow, which is run over a tray carried on the end of a curved rack (T); the rack, being run up through suitable gearing by means of the handles (R), raises the projectile to the level of the gun, and it is then rammed home by means of an ordinary rammer.

Electric Safety Firing Gear.

This consists of a system of electric leads and contacts arranged on the gun and carriage, in order to ensure that the electric firing circuit can only be completed when the gun is in the firing position.

The safety arrangement consists of a contact bracket attached to the elevator, and another attached to the sighting platform.

The battery and key, test and firing, and the firing key with bracket, are described at page 73. The battery is supported in a tray which is attached to a plate bolted to the side of the carriage. The firing key bracket is secured to a plate which is fixed to the sighting platform, and convenient to the layer.

The electric cables are of D 13 cable, secured to the gun and carriage by the ordinary double retaining clips with screws; they are in suitable lengths, and arranged thus :—

	No.
From battery to contact on sighting platform	1
From contact on elevator to gun	1
From battery to firing key	2
From gun to battery (for return current)	1

Pumps, Air and Water.

Two pairs of pumps, one for water and one for air, are placed in the front transom, and are actuated by a cross shaft and hand wheels (Q) on each side. These pumps are intended for forcing air or water into the vessels, or for lowering the gun from the firing into the loading position; this is effected by pumping the water from the cylinder into the air vessels.

The pumps are thrown in and out of gear with the cross shaft by means of forked clutches acting on the wheels, and a slow and quick gear is provided for each pump.

The water pump is provided with two suctions, which can be opened or closed by means of stop valves. When facing to the rear the valve on the right opens communication between the pump and the recoil cylinder, and is used when pumping down the gun into the loading position; that on the left opens to a flexible hose, which is used to draw from a bucket when more water is required in the cylinder.

On the front end of the right air vessel is fixed a pressure indicator.

On the front of the left air vessel is a glass water gauge. When the gun is down, the water should stand at a line marked on the glass. These gauges are covered by sliding lids; as a rule they should be kept shut off from the air vessels.

The men attending to the traversing, elevating, and pumping are protected by the parapet.

The following are the principal dimensions:—

Diameter of gun pit at top	34·0 feet
„ „ bottom	40·0 „
Depth to upper surface of racer	13·0 inches
Fall of gun vertically	9·0 feet
Length of trunnion path	14·3 inches
Diameter of recoil cylinder	32 „
Stroke „ „	3 feet 6·56 inches
Air pressure—gun up	300 lb. per sq. inch
„ „ „ down	500 „
Water level distance below top of base of gauge glass	48 inches

The following sighting gear is provided, and it is demanded separately:—

Gear, Sighting.

Carriage sights of the rocking-bar type are generally similar to that described for Mark I disappearing carriage, page 57, but the frame carrying the sights is supported on a bracket which is secured to the front of the sighting platform (X^1, Plate XXXIII) instead of on a pedestal.

TRAY, SPARE PARTS.

This is made of deal or pine, and subdivided into compartments, similar to the "box spare parts" for the gun, *see* page 15, of such a size as to hold the necessary spare parts to be kept for the number of carriages in the work.

The tray is made locally.

CARE AND PRESERVATION OF CARRIAGES AND SLIDES.

See also "Regulations for Care and Preservation of War Matériel, &c."

All sights must be carefully protected when putting on, or taking off, the carriage cover.

Shafts and spindles having nuts secured by taper pins will be marked to correspond with each other, to prevent the nuts being placed on the wrong shafts or spindles. Nuts, shafts, or spindles will be marked locally with a letter or punch mark as most convenient.

Whenever any parts are found broken, defective, or deficient, which cannot be renewed by the artificer, fresh parts should be demanded at once. Any damage occurring at drill or practice should be reported, with a view to its being made good without delay.

Care, &c., of Barbette Mountings.

Mark I.

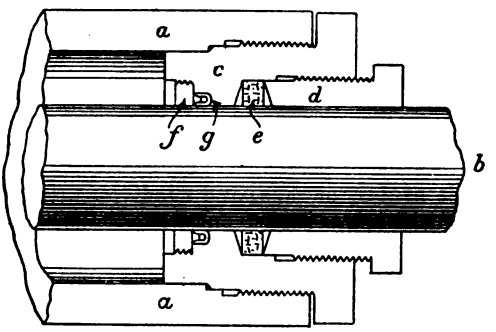
The Live Roller Ring (*C pivot slide*).—This must be lowered on to the roller path or racer evenly, the rollers being adjusted on their axles before doing so. See also instructions for Mark I disappearing carriage, page 71.

To Mount the Slide.—The slide, with clips removed, must be carefully lowered on to the live roller ring in the case of "C" pivot slide, and racer in that of "D" pivot, care being taken that the slide is directly over the pivot in each case, so that the pivot pin enters the bush fairly. The clips must then be replaced.

To Mount the Carriage.—Remove the front and rear clips from the inside of the carriage, and draw the outside front clips out to clear the flange on the slide; then lower the carriage, with piston rods, gently on to the slide, put on the clips, and secure the piston rods to the slide.

When the packing in the gland of the hydraulic buffer becomes worn, its pressure on the piston rod is lessened, hence leakage, and the metal gland must be forced farther into the stuffing box; if this does not stop the leakage, the gland must be re-packed.

The following are the parts of hydraulic buffer gland (for complete buffers, *see* Plate XIII) :—



a. Cylinder, buffer; *b*. Rod, piston. *c*. Gland, outer (stuffing box), metal. *d*. Gland, inner, metal. *e*. Packing, hydraulic, ¾ inch, square section. *f*. Ring, leather packing, metal. *g*. Ring, packing, leather, U-section.

To Renew the Packing.—Run the carriage back about 2 feet and block it up in that position. Empty the buffer, if necessary, by removing the plug on the under side. Unscrew the gland *d* (*see* above sketch), and slip it along the piston rod, to admit of the defective packing being extracted, which can be done with the tang of a file. Clean out the stuffing box *c*, slightly coat it and piston rod with mineral jelly. Pack stuffing box with new packing, which consists of ¾-inch hydraulic packing square in section; 64 inches for each buffer will be required, which will be cut into lengths each about equalling the circumference of the piston rod; the cuts will be made diagonally, so as to overlap when the piece is formed into a ring; well tallow each ring, press them successively into the stuffing box with a piece of wood, or former, taking care that the joinings are well separated so as to break joint; screw home the gland, but not too tightly at first, which would prevent free action of piston rod.

If the-U leather packings require renewal, it will be necessary to empty the buffers by removing the plugs from the under side, and disconnect the piston rods from the slide before running back. To do this, take out the pins (R) (Plate XIII) connecting the crosshead to the slide, run the carriage back, remove the securing pins (S) (Plate XIII), and unscrew the crossheads from the piston rods, which will allow the glands (*d* and *c*) to be unscrewed for the purpose of removing the metal rings and the old-U leathers, and to admit of the new leathers being inserted in the boxes. The new leathers must be thoroughly greased, and carefully placed upon the rods so as not to damage the edges, and well pressed home by the metal ring before inserting the hydraulic packing.

To fill the Buffers.—With the carriage in firing position, remove the plugs (D) from the cylinders (Plate XIII) and from the tank (L¹). Pour the fluid into the tank and pump it into the cylinders till it overflows at the plugs (D). Replace the plugs (D), and pour the remainder of the fluid into the tank, then replace tank plug, and the carriage is ready for firing.

On the left front of the carriage is a small bronze hand wheel; this opens or closes a passage from the tank to the buffers.

The instructions for its use are :—

Open.—To run up.

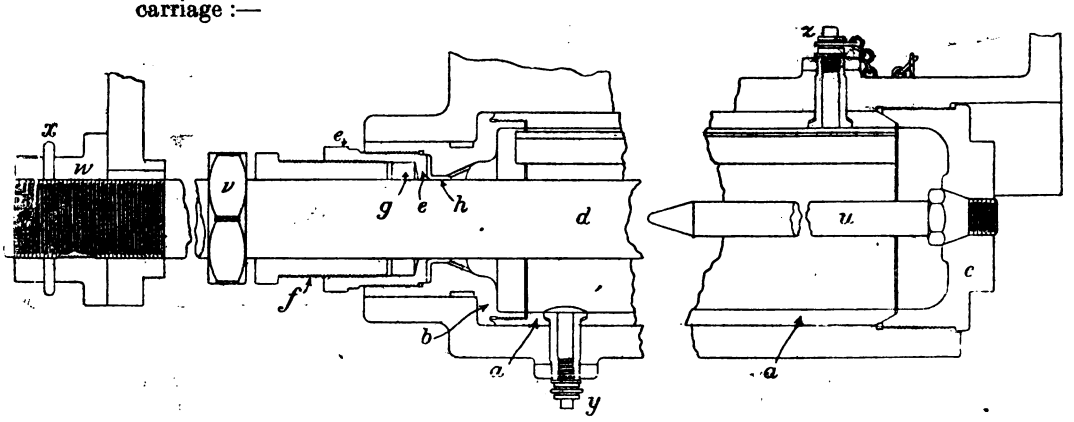
Close.—Before firing, or to pump back.

The motion to close is in the same direction as the hands of a watch.

The quantity of liquid required is about 18½ gallons of mineral oil.

Mark II.

The following are the principal parts of the buffer, Mark II barbette carriage :—



a. Cylinder, buffer. *b*. Cap, front. *c*. Cap, rear. *d*. Rod, piston, and controlling plunger *u*. *e*. Gland, outer (stuffing box), metal. *f*. Gland, inner, metal. *g*. Packing, hydraulic, $\frac{5}{8}$ inch, square section. *h*. Ring, packing, leather, L section.

To Renew the Packing.—The procedure will be similar to that before mentioned for Mark I, but 96 inches of $\frac{5}{8}$-inch hydraulic packing are allowed for each buffer. Run the carriage back about 2 feet, and block it in that position ; empty the buffer, if necessary, by removing the run off plug (*y*, *see* sketch on the under side) ; unscrew the gland and slip it along the piston rod to admit of the defective packing being extracted and replaced by the new, which must be well saturated with Russian tallow before insertion.

If the L-leather packings require renewal, it will be necessary to empty the buffers, disconnect the piston rods from the slide before running back the carriage. To do this, take out the securing pins *x* in the front nuts *w* on the piston rods, and remove these nuts (from each rod) ; run the carriage back, block it, and remove the inner nuts *v* from the rods ; unscrew the stuffing boxes and remove them, and take out the old leathers. The new leathers must be thoroughly greased and carefully placed upon the rods, so as not to damage the edges, and well pressed home by the metal gland before inserting the hydrauic packing.

In re-connecting the piston rods with the slide, care must be taken to replace the parts so that the adjusting gear for the buffer will be in working order.

To Fill the Buffers.—See that the carriage is hard against the front stops, and that the run-off plugs *y* are screwed tight home ; remove the filling plugs *z*, insert the gallon measure in one of the filling holes, run in sufficient fluid to fill the cylinders (about 12½ gallons of mineral oil for each buffer). To draw off a small quantity of the fluid, the run-off plugs should not be unscrewed more than a quarter of an inch, as the fluid will flow through small holes drilled in the plugs for that purpose. (To empty the buffers, these plugs must be unscrewed entirely.) The buffers may also be filled by using the running-back pump for this purpose. If this method be preferred, connect the delivery pipe of the pump to the filling hole of the right cylinder, see that the release

valve is closed, remove the filling plugs from the pump cistern, and pour in the fluid; work the pump till the fluid overflows at the filling hole of the left cylinder, replace the plug in this hole, and work the pump till the carriage begins to move, replace the plugs in the pump cistern. The working contents of this pump is six gallons.

To alter the size of the piston openings, slacken back the nut in front of the hand lever, and move the lever until the required amount of adjustment is indicated on the scale. The jamming nut must then be tightened up.

The mounting must be lifted on the hydraulic pivot from time to time. Care must be taken that the glycerine in the pivot, tank, and connections is clean and free from grit. The liquid is 65 lbs. of glycerine per mounting (rather more than 5 gallons). The pump valves and seatings must be examined occasionally and cleaned; this can be done by removing the screw plugs over the valves. The leather packings in the plungers and stuffing boxes, and the washers under the plugs and in the unions, must be renewed when found necessary. Should the amount of vertical lift in the pivot be insufficient, it can be increased by adjusting the length of the outer link connecting the pivot band with the pump; the exact amount of lift can be seen on the index provided for the purpose. If the mounting should at any time be removed from the pivot, the greatest care must be taken to protect the pivot, ram, and cylinder from abrasion.

The band round the pivot block must be periodically lubricated. This band must on no account be disconnected, or the joint pins withdrawn from the supporting frame, unless the carriage is dismounted and the slide properly blocked up, but this should only be necessary when the mounting is being removed.

To run the Carriage back by Pump.—Hook the lifting derrick provided into the hole made in the top of the right-hand side of the carriage, and hang the chain blocks on the end of the derrick; lift the pump into its place and clamp it down with the screws provided for that purpose. Connect the delivery branch of the pump with the filling hole of the right-hand buffer by means of the connecting pipe provided.

To run back.—See that the release valve under the pump cistern is closed, and work the pump handles.

To run up.—Open the release valve.

As the running back gear is only provided for purposes of drill, it should be removed before commencing firing practice.

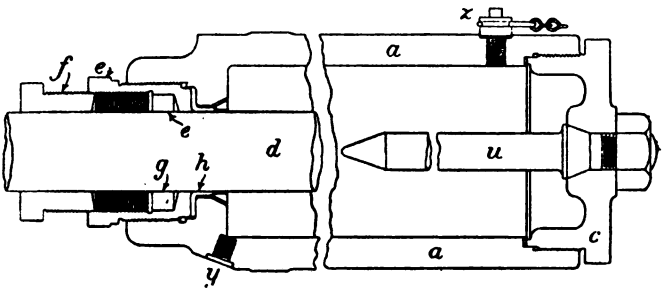
The running-back pump must be examined occasionally to see that the valve seatings and other important parts are in good order; the valves can be got at by removing the plugs in the cistern and in the bodies of the pumps.

The leathers in the stuffing boxes, unions, and on the plugs must be renewed when necessary.

To Dismount the Carriage.—Disconnect the hydraulic buffer rods from the slide, and the front clips from the carriage, remove the rear buffer spindles from the slide; run the carriage back until it is in contact with the rear buffer stop brackets. The rear clips will then pass through openings in the upper flanges of the slide girder made specially to admit of the removal of the carriage.

Mark III.

The foregoing instructions for Mark II mounting will generally apply to Mark III, except that the quantity of fluid for each buffer is about 11¾ gallons of mineral oil. The parts of the hydraulic buffer are also similar, *see* sketches.



To dismount the Carriage.—Remove the covers of the elevating worm wheel and sliding bracket, and take out the worm shaft. Remove the front and rear clips from the carriage; disconnect the buffer rods from the slide, and run the carriage back till the ends of the rods are clear of the front transom of the slide. The carriage can then be lifted out.

Mark IV.

Before the erection of the mounting is commenced, special attention must be directed to the following points:—

(i) In cases where 132° 30′ traverse on either side of the centre line passing through the front and rear of the emplacement is required, it must be noted that the centre line of the key way for the pivot plug should be 2¼ inches to the left rear of the centre line of the emplacement. Where more than this traverse is required, the telescopic exhaust pipe should be replaced by a sphincter grip hose, and the traverse should be limited by means of the traversing stops.

(ii) The stops for limiting the angle of traverse, which are to be fitted locally, must be so arranged that when the springs on the traversing stops are compressed, the telescopic exhaust pipe is clear of the centre pivot pipe bend.

(iii) The instructions as to level of racer, correctness of upper path, and live roller ring hereafter mentioned for the Mark I disappearing mounting, will also apply to this mounting.

To Mount the Carriage.—The carriage is mounted on the live roller ring, the centre pivot in position, and the clip plates secured; the carriage should then be given two or three revolutions to see that it works correctly.

To Mount the Cradle.—Insert the lower part of the gun band in the cradle; mount the cradle in its trunnion bearings, the elevating arcs being previously attached, screw on the capsquares and fix the ball bearings in position on the end of the trunnions. Attach the hydraulic pipe to the swivel joint on the left hand trunnion. Secure the nut in

the recoil buffer stuffing box, and the compressor rams to the lugs on the gun band; it may prove convenient to force the buffer tube or cylinder into the recess on the lug of the gun band by slight air pressure pumped into the air chamber.

To Mount the Gun.—Remove the capsquares from the cradle sides, lower the gun into the cradle, replace the capsquares, and secure the upper part of the gun band in position.

Care must be taken before firing that the plates of the friction clutch of the elevating gear are quite free from grit, oil, or liquid, in accordance with instruction which will be found in the "Regulations for Care and Preservation of War Matériel, &c.," in putting the clutch together, and to tighten it up sufficiently, the power of four men will be required on the special spanner.

Fill the buffer tube in strict accordance with the instructions on the plate on the side of the cradle.

Mineral oil is used in the buffer, which will be invariably kept filled, and before filling care should be taken that the gun is within 2 inches from the front stops. Before replacing the air-hole plug it should be seen that as little air as possible remains in the buffer. This may be minimised by raising the gun a few degrees from point blank while filling the buffer. To ensure the controlling ram chamber being full of liquid, slacken the gland on the front end of the piston rod, and pump in liquid until it passes the gland.

No permanent alteration should be made in the pressure laid down for the air chamber, and it should be noted that the pressure gauge is giving correct record.

Before firing it should be ascertained, by removal of the air screws in the compressors, that the latter are full of liquid, to ensure the accumulator being properly charged during recoil. It is also important that the lever of the controlling valve for the front and rear hoists is in the central position, and all valves are properly tight upon their seatings.

Packings.—By pumping liquid into the buffer cylinder, the gun may be run back to a convenient position for removal of the small gland and the renewal of the hydraulic packing; but for renewal of the L-leather the buffer of course must be emptied and the stuffing box removed, the gun being properly secured in a suitable run-back position. The packing is the service "hydraulic"; it is woven square in section with a rubber core, and is supplied by length. For use it is cut into full lengths, which are prepared and adjusted in the usual way.

The ball bearings of the cradle trunnions should be properly adjusted and kept well lubricated.

To Prepare for Firing.—Charge the intensifier and main gland by pumping in oil at the valve marked "A," which is on the right side of air chamber near the rear, let air escape at "C," which is on top of air chamber near the front; when beginning to pump the piston should be at the rear. The piston rod of the intensifier may also be forced in by screw clamp (for description, *see* page 30), and oil poured in at "A," using a funnel.

Charge the air chamber through valve "D," which is at the rear of air chamber, to a pressure of 250 lbs. per square inch; about 3 quarts of oil should be in the air chamber, to act as a lubricant.

With the gun at elevation, fill the buffer with oil by pumping in at valve "E," which is at the under side of buffer cylinder near the front,

letting air escape at " B," which is on top of cylinder over " E." Draw off ¼ pint.

To Fill the Accumulator System.—Place the gun at depression touching front stop; close valve " B," bye-pass valve of pump. Close " C," which is immediately under the pump spindle. Slacken all glands and air screws, tightening each as the liquid runs out. Place the controlling valve handles of front and rear hoists at " raise," returning each to the mid position when the air screws are tightened. Fill the tank through the hole in the cover till the liquid shows well in the strainer. Open valve " D," which is in the T-connection under valve " A," connecting pump with compressors on cradle, and pump them full; close " D." Pump the accumulator rams up to their highest and normal position.

To lower accumulator rams, open valve " B." The tank should be full when the rams are in their lowest positions. The valve " A," which is at the side of the accumulator, should only be closed in case of accident to the compressors on the cradle.

Action.—All the air screws being opened, the compressors are filled as above by opening the stop valve for pump, and pumping fluid from the tank; on closing the valve the remainder of the system is filled; as soon as the hoists are seen to rise the controlling valves should be closed, and continuous pumping raises the accumulator rams, compressing the main springs. As the gun recoils fluid is forced from the compressors into the centre cylinder of the accumulator; the side cylinders being filled, drawing from the tank, the surplus fluid is forced through the relief valve, into the tank. As the gun runs out fluid is drawn from the tank through the suction valve into the compressors, the accumulator stop valve closes, and the pressure in the accumulator cylinder is equalised by fluid passing through the small hole in equalising valve; the accumulator pressure raises the delivery valve and will lift the hoists when admitted to them by the controlling valves; the hoists are lowered by reversing the position of the controlling valves, the fluid flowing back into the tank. The accumulator rams can be lowered by opening the bye-pass valve.

Liquid for :—

Hydraulic buffer, 9 gallons of mineral oil, normal quantity per carriage.

Accumulator system, 45 gallons of " fluid, lifts and jacks hydraulic," normal quantity per carriage, but as the distance of the accumulator from the carriage is not the same in all emplacements, additional fluid will be supplied where required.

The hydraulic system should be tested when it is first erected, or after any extensive repairs.

To test the Gun pressure Pipes and Fittings for Soundness.—Slacken all air screws and tighten them when fluid begins to run out. Empty the the tank, close the inlet valve, and open the stop valve for pump. Remove the equalising valve with its spring seat and screw in the blank seat supplied. Pump the accumulator rams to their highest positions, supplying fluid to the pump chamber and not to the tank. If all be sound, close the stop valve for pump, and the stop valve centre cylinder, open the inlet valve and bye-pass valve, thus lowering the rams. Remove the blank seat, and replace the equalising valve with its spring and seat. Close the bye-pass and open the stop valve.

To test the Accumulator, pressure and Exhaust Pipes.—Slacken all air screws, and tighten them when fluid begins to run out. Place the controlling valve levers at raise. Open the stop valve for pump, pump the accumulator rams and hoists to the highest position, supplying fluid to the tank. If all be sound, close the stop valve for pump and place the controlling valve levers at "lower," thus testing the exhaust pipes. Should the exhaust pipes be so long that the two hoists will not fill them, raise and lower one hoist once or twice.

The valves and seatings of this hydraulic system should be kept clean, and to prevent lodgment of any foreign matter due to the rush of liquid, the latter should be occasionally pumped off from the accumulator system, and filtered before it is replaced, and this shall always be done on completion of first firing, after erection.

Protecting Wooden Covers for Roller Ring.—The covers, which are right and left, are for protecting the exposed portions of the roller path and ring from dirt and grit.

Care, &c., Disappearing Mounting.

Mark I.

Before erecting the mounting, the following points must be attended to :—

1. The racer should be perfectly level.
2. The roller paths (upper and lower), teeth of traversing rack, underside of clip ring and rollers should be quite clean and free from burrs.
3. It should be seen that the roller ring has not been bent.
   The rollers and axles must be oiled, placed in the roller ring, and the ring given two or three revolutions on the roller path before putting on the mounting, to ascertain whether it runs truly, and that every roller bears continually. Two to four men should be able to move it freely.

The roller path on the underside of the mounting having been cleaned, oiled, and any burrs removed, the mounting should be lifted into position.

The traversing gear should next be attached, and one or two revolutions made to see that the mounting traverses freely. The truth of the racer may be tested here by a spirit level placed on any part of the mounting; as the mounting is revolved the bubble should remain stationary. The brackets for the pillars supporting the shield, and the front and rear holding-down clips having been added, another revolution should be made, to ascertain that the clips do not bind on the clip ring. Two men should traverse with ease. The chequered foot plates should then be placed in position, and the lever handle of the raising valve keyed on its shaft. The cylinder is filled as previously described; it holds about 70 gallons of liquid.

Mark Ia.

The working pressure in air chamber is 1,425 lbs. per square inch gun down, and 915 lb. per square inch gun up. The hydraulic buffer is filled in the ordinary way; it holds about 17 gallons gun down, and 12 gallons gun up, the difference being in the tank.

Adjustment of Valves.
(Plate XXXI.)

Should the recoil be unsatisfactory, it can be adjusted by altering the plug of the valves, but they should not be altered unless absolutely necessary.

All the valves in a recoil cylinder must be altered together, and set alike.

Mark I Recoil Valves (*Fig.* 2).—To get at the valves the pressure must be let out and the covers removed. Unscrew the keep screw (*d*), turn the nut (*b*) until the keep screw comes opposite to the next slot in the spindle, and screw in the keep screw, great care being taken to see that the keep screw is properly secured. The spindle is divided into eight divisions or slots, each division altering the lift 0·0104 inch. Detailed information as to the difference made in recoil is stamped on each valve, together with the amount of normal lift of the valve with which it is issued. This is necessary as a datum, since the adjusting nut can be turned round till it comes off. If it becomes necessary to remove this nut, the opening allowed to the valve after resetting should be measured. The actual amount of lift given is best measured by filing down a slip of metal till it fits the gap left between *b* and *a* where the coils of the spring give access, and then measuring the thickness of the slip.

Marks II, II, and III Recoil Valves* (*Fig.* 3).—These will be set as follows :—

1. The normal settings for full cordite and powder charges are :—
B.L. 10-inch (Mark I carriage), cordite 0·25, and powder 0·07.

As, however, there may be slight variations in mountings, an adjustment from the normal may be necessary for particular mountings ; this adjustment will be carried out by removing the cover (*a*), keep screw (*b*), stop (*c*), and turning the valve spindle (*d*) until the pointer (*e*) corresponds with the required graduations on the index plate (*f*). The index plate is graduated in 20 divisions, each representing $\frac{1}{100}$ of an inch lift to the valve. After the necessary adjustment has been made, replace the stop, keep screw, and cover.

This valve can be adjusted without the pressure in the cylinder being blown out.

2. Stamp each recoil valve as follows :—
The letter " P " after the figures, denoting the normal lift for powder charge ; and the normal lift for cordite charge underneath, with the letter " C " against it.

Adjustment of raising Valve and repacking its Gland (*Fig.* 1).—The gland of the spindle of the raising valve can be repacked without blowing out the compressed air from the recoil cylinder. If, however, there is a leak from the outer chamber to the inner through the raising valve itself, the pressure must be let out before the valve spindle (*a*) or its seating can be looked to.

To repack the gland, fasten the elevator down by the clips, and take off the nut (*e*) on the end of the valve spindle. Remove the stop nut from the end of the rack (*f*), pull out the rack, and remove the bracket (*g*) and toothed wheel (*d*) from the valve spindle. The gland nut (*c*) can now be unscrewed, and the gland repacked, care being taken not to disturb the gland box (*b*) unless for the purpose of replacing the lead packing (*l*), when the pressure must be let out

and the gland box screwed up again before the packing of the gland commences. In doing this care should be taken not to use too much force, as the gland box is rather weak. In replacing the gland nut it should not be more than a ¼ inch from "home."

Replace the toothed pinion bracket and nut, pinch the top of the pinion round from left to right until it can be moved no longer (taking care that it is not bearing against the gland nut), which will show that the valve is bearing on its seating; then pinch it back sufficiently from the right to left, drop in the rack, and screw in the stop at the end of it; connect up the link in the cut-off shaft to the top of rack. Replace the cover of the bracket, release the holding down clips of the elevator, and let the gun rise carefully. When the gun is "up," readjust the cut-off chain or rod wth slotted link.

ELECTRIC FIRING.

Mark IV barbette carriage has a special system of electric firing gear, which is described with the carriage.

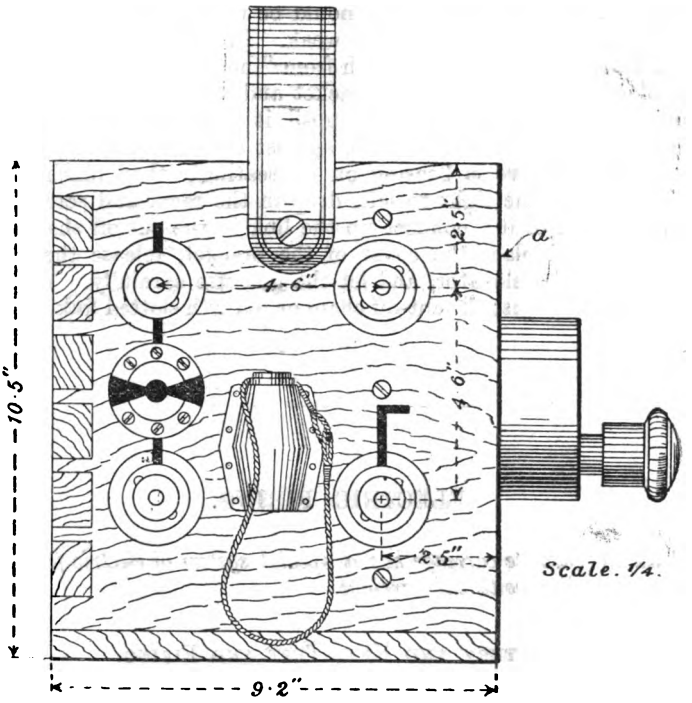
Battery and Key, Test and Firing.

Marks III** and IV batteries are in present use. The former mark has been brought up to date to take the Mark III Le Clanché cells.

Mark IV Battery.—The box (Mark I) is of teak, with key and plug, but without cells. It is made to the form and dimensions shown in Fig. 1. The upper left-hand terminal is in electrical connection with the positive pole of the battery, and also with the upper portion of the plug socket, as shown by the thick black line. The lower left-hand terminal is in connection with the lower portion of the plug socket. The right-hand lower terminal is in connection, through the key, with the negative pole of the battery. The right-hand upper terminal is not in electrical connection with any other part of the apparatus. It is merely used as a binding screw in connecting up a circuit.

A brass plug with ebonite head is provided for completing the circuit through the plug socket when desired; it is carried in the holder when not in use.

FIG. 1.—Side Elevation. Scale ¼.



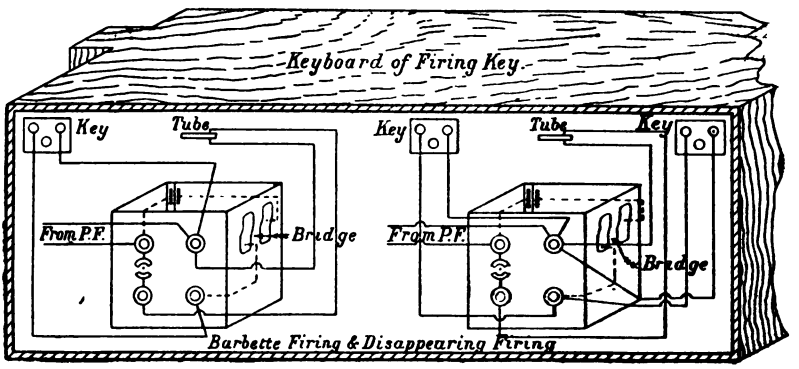
A diagram of internal and external connections, as shown in Fig. 2, is fixed at *a*.

To clearly indicate the terminals to which electric firing leads are to be connected, "segments" of celluloid are fixed to the battery as follows :—

Coral	.. ..	Near the right hand lower terminal.
White	.. ..	Near the right hand upper terminal.
Black	.. ..	Near the left hand upper terminal.
Turquoise	..	Near the left hand lower terminal.

Similar coloured "sleeves" of celluloid are attached in a convenient position near the ends of the leads (*see* Leads, page 76).

FIG. 2.



The cells are separate stores. Two cells, electric, Le Clanché A (Mark III), are fitted in and connected up in the battery box; they are issued with the sal-ammoniac in them and sealed; all that is required to make them ready for use is to fill them three parts full with water, and to see that this is added from time to time to make up for evaporation (*see* Care and Preservation, page 81).

To keep the cells steady in the box when firing the gun, packing pieces of asbestos and a wood saddle are provided.

The firing key and battery is designed to serve two purposes :—

(i) To test the tube and circuit when the gun is made ready to fire.

(ii) To fire the tube.

To enable this to be done an indicator is fitted within the firing key itself, which is so arranged that when the handle or knob is turned to the right the current passes through the indicator and the rest of the gun circuit, and if this is complete a visible and audible signal is given. If it is then required to fire, the knob is pressed in, which action cuts the indicator out, and allows the full current to flow through the circuit, firing the tube.

An arrow is cut on the face of the knob of the key in position that when the arrow is upright the knob is in the safe position. The arrow is painted white, and when vertical the circuit is broken, and the gun cannot be fired.

Besides this the apparatus may take the place of the Menotti cell and galvanometer for testing tubes and firing wires.

The apparatus is suitable for firing any low tension fuze or tube through a short length of wire, about 50 yards of No. 16 copper wire (0·065 inch diameter).

Precautions to be observed.—Testing the Circuits.

Before any wires are attached to the key, care should be taken that the arrow on the knob points upwards, and the key should be tried to see that it works freely and correctly.

The firing wires must not both be connected up until after the gun is laid and ready to fire, and the front is clear. The turning of the knob should be done just before it is required to fire, and it may either be held turned or not, as desired, until the gun is fired, by pressing it in; *this should be carefully attended to, so as to avoid delay in firing through pressing the knob before turning it.*

The following rules will detect the particular cause of failure to fire with electric tubes :—

(1) If the indicator works properly and yet when the knob is pressed the tube does not fire, the fault is a short circuit between the firing leads, or in the tube itself.

(2) If the indicator works feebly only, some bad joint in the circuit will be the probable cause.

(3) If it does not move at all, the circuit is broken at some point in the wires or in the tube itself.

(4) If the indicator works when the knob is turned and the gun does not fire when it is pressed, and then when the knob is turned again the indicator does not work, this shows that the tube has fired without igniting the charge.

To eliminate faulty tubes it is as well to test them before use out of the gun. This should be done under precaution, so that in the case of a tube being accidentally fired, no damage would ensue. The firing leads may also be tested; and the apparatus may be considered to be in good order if on *joining the terminals with a short piece* of *wire* and turning the knob the indicator works well. If it should only work feebly the battery should be examined, as in this case it will not give sufficient current to fire with certainty.

Arrangement of Leads.

The leads throughout the electric firing system are composed of—

Cable, electric, unarmoured, D 13 (single core, braided).

Or suitable lengths of the following may be used—

Cable, electric, unarmoured, D 9 (2 core), 15 (single core), as permanent leads.

Wire, electric, covered, C 21 (twin).

To clearly indicate the terminal to which electric firing leads are to be connected, "sleeves" of celluloid, coloured coral, black, white, and turquoise respectively, are attached to the ends of the leads (in a convenient position), and corresponding to the celluloid "segments" fixed near the terminals of the "Battery and key, test and firing," and "terminal boards."

A sleeve is placed at each end of any one lead, and both are of the same colour.

A binding screw attached to a wooden block is fixed to the lower part of the supporting bracket or tray of the battery, so that leads not in electrical connection with any other part of the system may be attached. This screw and wood block are made and fitted locally as required; *care should be taken that no electrical connection is made between the binding screw and the bracket or tray.*

Full particulars as to position finding arrangements will be found in a separate handbook.

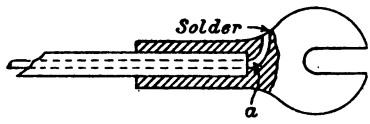
1. *Barbette Mounting.*

The leads from the position-finder firing circuit terminate at the P.F. safety plug or dial box recess. From thence a length of "cable electric, D 13," is led through an iron pipe placed under ground, by the most convenient route, to the junction terminal box. This box, which is of cast iron, contains two terminals, and is fixed in the floor of the emplacement, flush with the concrete, on the centre line of the arc of fire, and as near as possible (but varying with the mark of mounting, and must be arranged locally) to the centre of the pivot.

The iron pipe is attached to the nozzle on the box provided for the purpose, and the joint made watertight. The two wires of the D 13 cable are attached to the back of the terminals on the terminal board by means of brass nuts.

Another length of D 13 cable is attached by open washers (soldered to the ends of the wires as hereafter described) to the terminals in the box, and is passed through the gunmetal gland in the lid and thence through an open ring staple to the terminals D (*black*) and F (*white*), on the "Battery and key, test and firing" (*see* Fig. 3), to which the wires

are attached by open washers. These washers are made of metal (locally as required), formed with a socket at one end for the reception of the lead, the core of which is passed through the small hole (*a*), *see* sketch, and soldered.



The open-ring staple is fixed to the slide in such a position as to enable the cable to be conveniently led to the "Battery and key, test and firing," which is situated on the side of the slide.

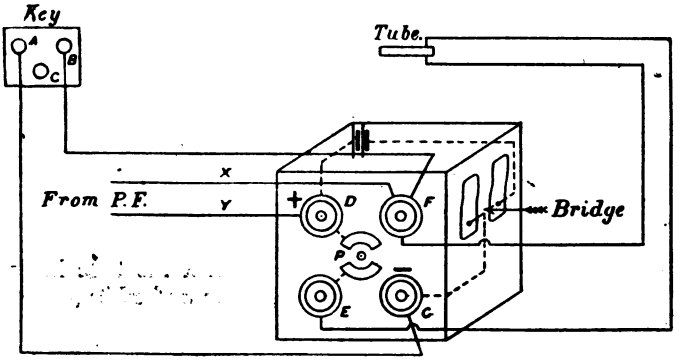
The length of the cable is to be such that sufficient slack is left below the open-ring staple to admit of the full traverse of the mounting.

The terminals G (*coral*), F (*white*), on the "Battery and key, test and firing," are connected to the terminals attached to the firing key bracket, which is described below, by permanent leads of D 13 cable provided with open washers at each end, attached to the mounting by brass clips, secured by screws, as stated below for emplacement and P.F. firing respectively.

The route followed by these leads is to be that most convenient for each mark of mounting.

From the terminals E and F on the firing battery, two lengths of cable, electric, D 13, with open washers for attachment to the terminals, and points to fit the tube wires, are conveniently attached to the mounting, and complete the circuit to the tube.

FIG. 3.



The firing key bracket referred to above is fixed to the handrails on rear of the slide convenient for the firing number. It is fitted with three binding screws (*see* Fig. 3), marked "Tube," "Battery," "Tube battery" the latter was formerly used when the bracket was used on "barbette" mountings. A spring is attached to the back of the terminals, marked "Tube" and "Battery" respectively, for making contact with the firing key.

The terminals, A, B, C, are lettered thus —

A BATTERY ◯, B ◯ TUBE, (red) C BATTERY ◯ TUBE.

These terminals are on the back of the firing key bracket, and protected by a hinged cover. As before stated, C is not now used.

When the firing key is not required in the bracket, a wooden slide or circuit connector (Figs. 4 and 5), fitted with a brass spring, is placed in the bracket for completing the circuit. Slides fitted with a firing key bracket on both sides, as shown in Fig. 6, the leads being "in parallel," it is important that it should be clearly borne in mind that only one circuit connector or wood slide is to be used, which should be either in the battery or in one of the firing key brackets. The bracket not in use will be left vacant, as should a circuit connector or wood slide be inserted while one is already in the battery, the circuit would be completed and the gun prematurely fired when the safety plug is inserted.

FIG. 4.

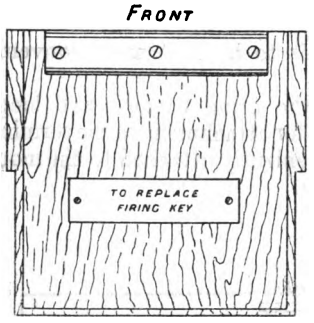
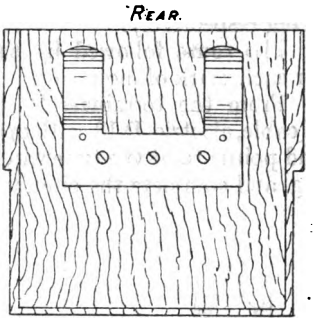


FIG. 5.



Size ¼.

Wood slide or connector of firing key bracket.

Firing from the { *Emplacement.* / *Position Finder.*

FIG. 3.

For emplacement firing.—The two leads from the tube in gun are connected to the terminals E and F (*turquoise and white respectively*). Two other leads are placed from A to G (*coral*) and from B to F (*white*). The circuit is then complete, and only requires the insertion of the plug P to enable the gun to be fired. The firing key must be removed from the socket on the board of P.F. safety firing plug, if one is installed.

For firing from Position-Finder.—The two tube wires are connected to E and F as for emplacement firing, and the two leads from the position finder circuit are attached to D (*black*) and F (*white*) respectively. The insertion of the plug P then enables the gun to be fired. The firing plug must be inserted in the socket on board of P.F. safety plug, if one is installed.

When the firing key is placed on its bracket, care must be taken to place the wood slide taken from the bracket in the receptacle in the battery box from which the firing key was taken.

If the key be turned for test with the firing plug P removed, the firing plug inserted in the socket on the board of P.F. safety firing plug, and the switch hand of the dial box at FIRE, the indicator not working shows that the firing relay in the dial-box is not "lifted."

If the key be turned for test with the firing plug P inserted and the switch handle of the dial-box not at FIRE, the working of the indicator shows that the tube circuit is in good order. It is immaterial whether the firing plug is removed from the socket on the board of P.F. safety firing plug or not.

Lead X, Fig. 3, must be taken to the right-hand binding screw of the P.F. safety firing plug, or to the terminal marked PLUG on terminal board B, if no safety firing plug is installed.

Lead Y, Fig. 3, must be taken to the left hand brass binding screw of the P.F. saftey firing plug, or to the negative pole of the P.F. firing battery, if no safety firing plug is installed.

2. *Disappearing Mounting, Mark* I.

The connections are arranged as shown in Fig. 6. Precautions to be observed in the case of mountings fitted with two firing key brackets, tests of circuit, and colour of celluloid sleeves, are as for "barbette" mountings just mentioned.

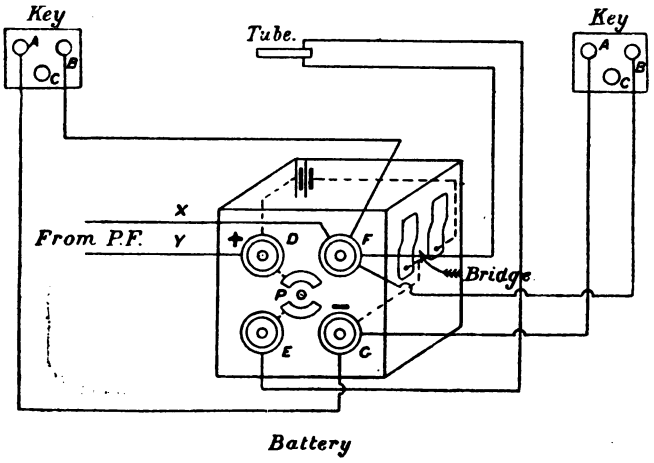
The lengths of D 13 required will depend on the position of the P.F. safety firing plug or dial box recess and firing key bracket, and must be stated in local demands.

Firing from the { *Emplacement (sighting platform in manhole).* P.F.

For Emplacement Firing from Sighting Platform, using Service Sights in Gun.—A length of D 13 cable is secured to the terminals A and G (*coral*) by an open washer at each end, soldered to the cable or conductor; another length is fixed to B and F (*white*) and similarly secured (or one length of "Cable, electric, D 9" may be used instead, the twin cable being separated and the ends connected as for the single cable). The terminals A and B are on the back of the bracket to hold the firing key, the bracket being situated on the handrail in a convenient position for the gun layer to manipulate, without obliging him to lose his sighting (*see* page 55). The "Cables, electric, D 13 are led by the most convenient route from the contact bracket on the breech face of the gun, and permanently secured in position by clips attached to the gun and mounting. To prevent accidents by premature firing, the cables (D 13) are divided at a bracket near the lower end of the elevator, one cable is fitted with rubbing contacts (one on the lower carriage and one on the elevator), which automatically complete the circuit by coming in contact only when the gun is in the correct position for firing; the other cable is passed across the end of the round joint pin, and the cables are again joined and led to the battery on the lower carriage. The ends of the two cables from the gun are connected by open washers to E (*turquoise*) and F (*white*).

For Emplacement Firing from Manhole, using Carriage Sights.—The arrangements are similar to firing from the sighting platform, except that the leads of D 13 cable pass through the shield at the left side of manhole, and secured along under the shield, down left rear standard, and across the carriage in rear of the girders to the electric battery. The cables are connected to the terminals as shown in Fig. 6. Care must be taken that the slide (Figs. 4 and 5) referred to at page 78 is in its place in the bracket when the firing key is not, so that the electric circuit may be complete.

FIG. 6.



For Firing with the Position-finder.—The leads from the position-finder firing circuit terminate at the P.F. safety firing plug or dial-box recess. From thence two cables of D 13 are brought down the side of the emplacement through the pipe in the floor to the pit, and up through a hole drilled in the corner of the chequered footplate at the point where the circular girder joins the side girder of the carriage; the cables are then connected to the terminals D (*black*) and F (*white*) by the open washers. Sufficient of the cables must be left in the pit to allow for the full traverse of the carriage, and in the case of a mounting permitting of all-round fire, care must be taken to traverse back in the opposite direction to which it came (and not necessarily by the shortest route), so as to avoid the liability of fouling or breaking the cables in the pit. The leads X Y will be arranged as for "barbette" mounting.

When the firing key is placed on its bracket, care must be taken to place the wood slide taken from the bracket in the receptacle in the battery from which the firing key was taken.

Care and Preservation.

See also "Regulations for Care and Preservation of War Matériel, &c."

Battery.

The two closed Le Clanché cells are issued with the sal-ammoniac in them; all that is required to make them ready for use is to fill the cell three parts full of water, and to see that this is added from time to time to make up for evaporation.

When the battery fails to fire a tube, fresh saturated solution of sal-ammoniac should be added, the old solution being thrown away. The solution is easily made, by putting crushed sal-ammoniac into boiling water, until the sal-ammoniac will no longer dissolve, and a saturated solution is formed, which should be allowed to become quite cold, and then poured carefully into the cell, and some dry crystals added, to make up for loss by evaporation; in about 12 hours the cell should be ready for work. If the cells still fail to fire the tube, they should be exchanged and inspected.

The cells are insulated by being painted or paraffined; either process protects them from accumulations of films of damp, dust, or dirt, or depositions of salt out of the liquid, due to what is termed "creeping." To keep the cells secure in the box on the gun being fired, &c., packing pieces of asbestos are placed between and round them; and a wood saddle is placed in the box over the cells.

To prevent "creeping" all cells should be kept dry and clean, and for this reason they should be enclosed in painted or varnished boxes.

The connections of the battery must be kept bright.

Wires.

Electric wires or light cables should be perfectly free from kinks, and insulated to prevent as much as possible waste of current.

They are issued sheathed in insulating material; but joints should be covered or insulated with the materials as allowed by "Equipment Regulations."

In making joints the ends should be prepared by being thoroughly cleaned by scraping or with emery cloth or sand paper.

PUMP, RUNNING BACK, PORTABLE, MARK I.

With Stop Valve "A"; Carriages, Garrison, B.L. 12-inch; Barbette, 10-inch Mark IV, and 9·2-inch, Marks III, IV, and V.

(*Plate XXXIVa.*)

This pump is used for running back the above-mentioned carriages at drill, &c.; it is of the ordinary double-acting hydraulic type, and is designed so that the liquid pressure will act on the pistons of the hydraulic buffers. It is contained in a portable tank, on wheels, so that it may be conveniently moved from one carriage to another.

The pump itself consists of a metal casting (*a*, *a*) fitted with plungers (*b*, *b*), which, when actuated by the handles (*c*, *c*) through (*d*), draw the liquid through the inlet valves (*e*, *e*), and force it past the delivery valves through the pipe into the hydraulic buffers or buffer, as the case may be; the pressure acting on the pistons of the buffers causes the carriage to run back. When run back, the carriage can be retained in that position by closing the stop valve on the buffer.

The "pipes, copper, connecting, $\frac{1}{4}$-inch bore," used with the "pump, air, double," and "pump, air or liquid," are also used for connecting the portable running back pump to the above-mentioned carriages.

Adapters are used for connecting the copper pipes to the portable pump.

Before commencing to pump a carriage back, the tank must be filled to a depth of 6 inches with the same description of fluid as is used in the hydraulic buffers.

When the carriage is run in, the liquid is forced back again from the hydraulic buffer to the tank through the return valve (*f*); this valve must be closed before commencing to pump the carriage back, and opened to run up.

Weight 5 cwt. 1 qr.

The following articles, referred to above, are used with the pump, as indicated opposite them :—

Pump, running back, portable (Mark I)—

Valve, stop, "A" (Mark I) ..	Steel and bronze.
Adapter, pump, running back, portable (Mark I).	G.M., with leather washer, for use with copper connecting pipes, $\frac{1}{4}$-inch bore.
Pipes, copper, connecting, $\frac{1}{4}$-inch bore by 10 feet—	External diameter, $\frac{7}{16}$-inch, for use with pump, air, double; pump, air, or liquid; and portable running back pump.
With unions (Mark I).	
With union and plug (Mark I).	

PUMP, AIR OR GAS, MARK I.

(*Plate XXXV.*)

The pump, which is designed to be driven by engine power, is intended primarily for charging reservoirs for hydro-pneumatic mountings with compressed air.

Pump.

The pump consists of four cylinders of different diameters, each fitted with a plunger, and connected by copper pipes (*a*); it is placed in a tank of water to keep the working parts and the air cool when charging.

The cylinders are metal castings, about 14 inches long, and are numbered 1, 2, 3, and 4, their respective diameters being $5\frac{3}{4}$, $3\frac{1}{8}$, $1\frac{11}{16}$, and $\frac{15}{16}$ inches. The differences in diameter admit of the air being compressed in stages, and ensures an approximately equal amount of work on the plungers when in operation. Each cylinder is packed with a U-leather ring and hydraulic packing, the latter being compressed

by a gland which is tightened from above by bolts. After the glands are packed, a small quantity of water is let into the cylinders through the valve to cover the joint and ensure a perfect sealing.

The cylinders are strengthened by a series of ribs running around them; they are in pairs (Nos. 1 and 3 in one pair, Nos. 2 and 4 in the other), and are bolted together in the centre, the whole, when in position, being supported by two steel standards (*b*), connected by diagonal cross stays (*c*). The upper ends of the standards are formed into bearings to take the crank shaft (*d*).

The plungers are of metal, and are cast hollow (except No. 4, which is solid and made of aluminium bronze), with an opening at the lower end of each, so that the cooling water may be in close contact with every part. They are worked by two forked connecting rods of metal (*e*), which are secured by caps to the cranks of the shaft. The lower ends of the connecting rods work in guides (*f*), to maintain the vertical motion, and are attached by caps to two cross heads, to which the plungers are fixed by bolts.

The copper pipes are connected to the cylinders by means of inlet and outlet valves contained in valve boxes (*g*), which form part of the cylinder castings. Both valves have coned seatings and are similar in form, but the inlet valve after each stroke returns to its seating by its own weight, while the outlet valve has a small spiral spring above it to ensure its return after the air has passed. The two pipes connecting Nos. 2, 3, and 4 cylinders are in long spiral coils, so as to present a greater surface to the action of the cooling water, and at the lower end of each coil is attached a small drain pipe, the upper end of which is connected by a union to a drain cock (*h*); this cock, when opened, allows any accumulation of water in the pipes to be blown off.

The valve box on No. 4 cylinder has two projections cast on it at right angles to each other; one projection forms a connection for the delivery pipe, the other is fitted with a coned relief valve (*i*), which is loaded by means of a spiral spring so adjusted that when the safe maximum pressure has been reached it will rise, and thus allow the air to escape.

The crank shaft (*d*), which is in one forging of steel, is fitted at each end to take a driving pulley. Both pulleys have an 8-inch face, but one is 3 feet 6 inches in diameter and the other 2 feet 6 inches, so that the number of revolutions can be altered as required by shifting the position of the driving belt.

The tank (*k*) is of steel plate strengthened with angle-pieces and galvanised; two parallel angle-pieces are riveted along the top ends, with holes bored through to suit 1¼-inch holding-down bolts (*l*), by which the tank is secured. A metal draw-off cock is screwed into the lower end of the tank.

The holding-down bolts will be made locally.

Extractor.

The extractor, which is for removing the coned seating of the valves, consists of a steel spindle, four cones, nut, collar, bearing plate, and key.

The spindle is 8 inches long, with a ½-inch screwed thread at one end, and a ⅜-inch screwed thread (⅝-inch long) at the other; in the centre is formed a square, to which are attached, by means of a sliding

cross-head, two hinged arms (each 3½ inches long), with a small projection at the end. The cones have each a ⅜-inch screwed thread in the centre for attachment to the spindle. The nut is hexagonal, with a ½-inch thread in the centre. The collar is 1⅝ inches in diameter, and the bearing plate 4½ inches by 1⅝ inches. The key is 6 inches long, with a square hole in one end to fit over a square cut on the spindle.

Method of use.—A cone (to suit the seating to be extracted) is placed on one end of the spindle, and the bearing plate, collar, and nut on the other; the arms and spindle are then passed through the seating, so that the projection at the end of the arms will engage with the underside of the seating, and the bearing plate will rest on the top of the valve box. The screwing down of the nut (the spindle being kept from turning by means of the key) extracts the seating from its bearing.

Maximum pressure obtainable, lb. per sq. inch 2,240.

PUMP, AIR OR LIQUID.

(*Plates XXXVI and XXXVII.*)

Mark I pump is double-acting, and is intended for charging the cylinders of hydro-pneumatic mountings with fluid or compressed air, and reservoirs with compressed air. It is contained in a metal tank (*a*) 2 feet 0½ inch in length and 1 foot 2⅜ inches in width, bolted to an iron stand, which is secured to a wood platform.

The pump consists principally of the following parts :—

(1) High and low pressure plungers; the former (*d*) is fixed to a crossbar (*e*) at the top of the tank, having a gunmetal washer inserted between the seating and the L leather, and the latter (*f*) to the bottom of the tank.

(2) Suction, intermediate (*h*), and delivery valves.

(3) Metal cylinders (*g*), formed at one end to receive the high-pressure plungers, and at the other the low-pressure plungers.

(4) Outer plungers (*i*).

(5) Overflow valves (*k*).

(6) Cock (*l*) for admitting air or liquid to the pump.

(7) Double-handle lever (*q*) for actuating the cylinders, and a double handled lever.

Mark II differs from Mark I generally as follows:—The tank is of an increased depth in order to ensure the high-pressure plungers being kept wet. Certain of the components are of "Delta" metal, to decrease the liability of corrosion.

Stand.

The stand, which is of cast iron, 7 inches high, is attached to a wood platform, 5 feet 9 inches long by 3 feet 5⅛ inches wide.

Adapter, A.

This adapter, which is for use with the connecting pipes of the "Pump, air, double," is a metal casting 2·625 inches long, with connections to suit the discharge nozzle of the "Pump, air or liquid," and the unions of the connecting pipes of the "Pump, air, double."

Adapter, B.

This adapter, which is for use with the connecting pipes of the "Pump, air or liquid," is a metal casting, 4·45 inches long, with connections to suit the unions of the connecting pipes of the "Pump, air or liquid," and the "Connection, indicator, pressure," in use with hydro-pneumatic mountings.

Pipes, Connecting.

These pipes are each 10 feet long, two with unions at each end, and two with a plug at one end and a union at the other.

Spanners.

The spanners are of steel, formed to suit the various parts of the pump, &c.

Arrangement of Connecting Pipes.

The pump is connected to the recoil cylinder of hydro-pneumatic mountings, or to reservoirs, by means of connecting pipes, which may be either those described above, or the connecting pipes of the "Pump, air, double," whichever are available.

When the connecting pipes of the "Pump, air double," are used for connecting to the recoil cylinder or reservoir, through a separator, the adapter "A" is first screwed on to the discharge nozzle of the "Pump, air or liquid," and the pipes are then connected as required.

When the pipes of the "Pump, air or liquid," are used for connecting—

1. To the recoil cylinder, the adapter "B" is first screwed on to the "Connection, indicator, pressure," in use with the mounting, and the pipes are then connected as required.
2. To the reservoir through a separator, three adapters, "B," are first screwed on, one to the nozzle of the inlet valve, one to the nozzle of the outlet valve of the separator, and one to the nozzle of the valve of the reservoir; the pipes are then connected as required.

Method of Use.

Pumping Air.—When charging with air, the lever working the cock (*l*) is turned to the side of the tank marked "air." On the up stroke of the cylinder, air is drawn through the cock, along the passages, and through the suction valve into the low-pressure cylinder (*n*). On the down stroke of the cylinder the air is forced through the intermediate valve (*h*), and compressed into the high-pressure cylinder (*o*), and on the next stroke of the cylinder is forced through the delivery valve and pipe (*p*) to the cylinder of the mounting or reservoir.

When first commencing to pump air, the area of the low-pressure cylinders can be increased, and consequently a larger volume of air pumped, by connecting the outer plungers (*i*) to the bottom of the tank. When the pressure is found to be too high for the pump to be worked by this arrangement, the outer plungers (*i*) are connected to

and move with the cylinders (*g*). The outer plungers (*i*) are connected to the tank or cylinders by turning the bolt locking plunger (*r*) on each side of the tank towards the words "low pressure" or "high pressure" respectively, with the spanner supplied by first pulling out the pin securing bolt locking plunger (*s*) and then inserting it in the opposite hole (*t*). *The connections must not be made until the cylinder is on the bottom stop on that side.*

Pumping Liquid.—When pumping liquid, the lever of the cock (*l*) is turned to the side of the tank marked "liquid," and the plug of the overflow valve is unscrewed sufficiently to admit the liquid in the tank into the low-pressure cylinder (*n*). On the up-stroke of the cylinder, the liquid is drawn through the intermediate valve (*h*), which in this case becomes the suction valve, into the high-pressure cylinder (*o*), and on the down-stroke of the cylinder is forced through the delivery valve and pipe (*p*) into the cylinder of the mounting.

Weights, &c.

	Weight.			Tonnage.
	cwt.	qr.	lb.	tons.
Pump	3	0	0	0·3695
Stand and platform	3	2	3	0·451

Maximum pressure obtainable, lb. per sq. inch 2,000.

PUMP, AIR, DOUBLE, MARK I.

(*Plates XXXVIII and XXXIX.*)

The pump is intended to charge the recoil cylinders of H.P. garrison mountings with fluid or compressed air.

It consists of two gunmetal cylinders (A and B) of different diameters in one casting, with a base plate, on the top of which an iron frame is bolted to form a tank (C) for the fluid while being pumped into the recoil cylinders. The pump cylinders are fitted with plungers (DD), actuated by a rocking lever (E) for each pump, which is supported on brackets (F) riveted to the tank.

The pump is in duplicate, and is bolted to an iron bedding plate (G), which is secured to the floor by clips (H) and cotters (I). It is worked by two T handles, which are attached to the rocking levers, and are connected at the top by a link to ensure uniform action.

When recharging the recoil cylinders with fluid, the fluid is drawn through suction valves from the tank into the large pump cylinders (A), and on the down stroke of the plunger is forced into the small cylinder through delivery valves. When charging with air, the connection between the tank and the cylinders is cut off by closing the

valves (K) near the copper delivery pipes, and the air is drawn through a suction valve at the bottom of the large cylinder. This valve is never cut off, but is more heavily weighted than the water valve, and when the water passage is open, liquid is drawn in in preference to air, provided the strokes are not too jerky.

Either pump can be disconnected if necessary, and worked independently; the delivery of either is cut off by closing the delivery valve. When this is closed, of course the handle must be disconnected, so that the pump cut off may not be worked.

The pump should be kept in store with the tanks full of liquid, and so used whether air or liquid is being pumped.

To keep the leathers in good order they should be slightly under pressure. To obtain this, screw one length of the copper tubing on the delivery nozzle (J), and on to the other end of the tube fix the blank cap (with packing leather). Then work the pump with the water valves closed until it becomes difficult to move the handles, when the pump may be left, the air in the tubing serving to maintain the pressure obtained.

When standing long in store the pump should be tried occasionally to see that the pressure is still on.

A cover is fitted to the iron bedding plate to protect the small pipes which connect the base of the pump to the three-way connection.

When it is found that the cylinders of the pumps are defective from excessive wear and scoring, they will be bored to a larger diameter, according to the amount of wear, and fitted with new plungers and L leathers. The thickness of the cylinders will not allow, at the most, of more than 0·15-inch enlargement, and this amount must not be exceeded. On the enlargement of a cylinder, the word "large" will be stamped on the new plunger.

Belonging to the pump are four connecting pipes, five spanners (Nos. 96 to 100), and one lifting loop.

Weight, 4 cwts. 1 qr.

Maximum pressure obtainable, lb. per sq. inch 2,800.

PUMP, TESTING COMPRESSED AIR RESERVOIRS.

(*Plate XL.*)

The body of the pump (*a*) (Mark I, Figs. 1 and 2), is of gunmetal with steel lever and connections, and copper reservoir (*b*). It is secured to a wood base by four bolts and nuts, the wood base forms part of the box hereafter described.

The plunger (*c*) is of aluminium bronze, and works through a metal gland screwed in to the top of the pump cylinder, and a U leather to make a tight joint; the leather is contained in the gland recess. The lower part of the cylinder is closed with a screwed bush with leather washer; this bush contains the inlet valve (*d*), which is grooved on the exterior to give passage to the water from the reservoir, the lift of the valve being regulated by a screw plug in top of the metal closing

bush; and the latter is screw-threaded on the under part to take the metal connection of the copper pipe of reservoir.

A recess in the head of the pump contains a metal outlet valve (*e*); this valve has grooves on its lower exterior, to allow the water to pass out to the compressed air reservoir, and a bronze spiral spring on its upper exterior keeps the valve in its seating; the recess is closed by a screw plug (*f*) and leather washer.

The channel from the outlet valve is continued through a metal bush (*g*), with leather washer, the bush being screw threaded on the outside to receive the connection of the delivery pipe.

The reservoir (*b*) (which is secured to the side of the pump by a metal band and screws) is of copper, with a connecting pipe (*h*) soldered to it, the other end of the pipe being connected up to the pump as before stated. Near the bottom of the reservoir is a wire trainer.

The BOX (Mark I) has a base board, with a footboard hinged to it, for the operator working the pump to stand on so as to steady the pump, and which is folded under when not in use. The cover of the box is provided with two metal lifting handles, and is put on over the pump and secured to the footboard by four thumb screws (*i*). The pump with lever and "Gauge, pressure No. 4," page 92, are arranged as shown by the dotted lines in Figure 3, the lever (*k*), and pressure guage (*l*) must be secured in position in the inside of the cover before the latter is put on.

Dimensions, &c.—The box is 19·6 inches deep, 13·5 inches long, and 8 inches wide. The pump, with box complete, weighs 51 lbs., and with pressure gauge, 55¼ lbs.

To prepare the pump for use, &c.

(1) Remove the cover of the box and extend the footboard.
(2) Attach suitable lengths of the connecting pipes used with the "Pump, air, double," the "Connection, pressure gauges," and the "Gauge, pressure."
(3) Partly fill the pump reservoir (*b*) with water.

Action.—When the plunger is raised by the up-stroke of the lever, the water is sucked from the reservoir (*b*) through the inlet valve (*d*), and fills the space in the plunger cylinder. On the down-stroke the inlet valve closes under the action of the plunger, and the water is forced out through the channel (*m*), the force raising the outlet valve (*e*), which allows the water to pass to the compressed air reservoir. On completion of this action the spring on the outlet valve forces the valve down on its seating and prevents the return of water. On the next up-stroke of the lever more water will be sucked into the pump, and so on till the required pressure per square inch, as registered in the pressure gauge for use in testing the compressed air reservoir, is obtained.

RESERVOIR, COMPRESSED AIR,* MARK II.

(Plate XLI.)

The reservoir is for keeping in reserve a supply of compressed air for re-charging the cylinders of H.P. mountings. It is in the form of a flask, with a short neck at one end fitted with a stop-cock (*a*), which is used for charging and discharging the reservoir; the outer end of the cock is screwed to take the nut of the charging pipe; the stop-cock is in two pieces, so that the pressure in the reservoir can be cut off and the outer part (*b*) removed when the reservoir is packed for transport.

As the reservoirs pass through the O.F. for re-annealing they will be strengthened by means of a steel collar which is screwed on the outside; and the valve seating provided with a hexagon head, to facilitate removal.

The pressure in the reservoir should not exceed 2,000 lbs. on the square inch when in ordinary use, or when travelling.

It should be remembered that more work will be got out of a reservoir if it is opened to the cylinder with the gun up in the case of disappearing carriages, than with the gun down, and in getting up pressure from zero with the aid of reservoirs, it will be done more quickly if the gun is allowed to rise.

A preserving plug, valve, union, valve key, with gland, and three grummets are issued with the reservoir.

Care and Preservation of Reservoir, Mark II.

See also "Regulations for Care and Preservation of War Matériel, &c."

As the reservoirs have to sustain a high pressure when fully charged, it is essential that they should be periodically tested to ascertain if they are in a serviceable condition, and annealed to preserve the tenacity of the material.

The testing will be carried out locally biennially, by pumping in hydraulic pressure up to 3,000 lbs. per square inch (from "Pump testing," page 87); any reservoirs failing to pass this test, or showing any permanent set or leakage, must be returned to store for transmission to Woolwich. *Before* and *after* testing the outside of the reservoir near the centre must be accurately gauged at four points, and the measurements recorded on a history sheet, which is supplied with each reservoir; the date of the biennial test must be stamped on the reservoir.

The reservoirs will be annealed every sixth year, for which purpose they must be returned to store for transmission to Woolwich.

Each reservoir will have a registered number stamped on it, also the manufacturing Mark or name, the numeral of the reservoir, date of issue, and annealing and test marks, with date as under:—

No. 56
J. B. and Co.
II
1896
(A) 10.3.96
(T) 11.3.96

The stamping of the date of test on the reservoir must on no account be done until the pressure has been let out.

A history sheet (Army Form G 881) will be issued with each reservoir. This sheet is intended to preserve a complete history of the reservoir from the date of issue from the Royal Arsenal to its final return to store. The

* The Mark I reservoir is not so strong as the Mark II; it is not issued for service with these carriages.

biennial tests and re-annealing will be recorded on this sheet, and also anything calling for special remark. The sheet must always be kept with the reservoir, and returned with it to store. Report of the entries made in the sheet are to be sent to the Chief Inspector, Woolwich, through the G.O.C. on the completion of the biennial testing (Army Form G 881A).

Filled reservoirs on R.A. charge should be marked with the word "filled," and with the amount of pressure in them.

Before returning reservoirs to store, they must be first emptied and the word "empty" stencilled on them.

Reservoirs not on R.A. charge should be stored empty, and so marked.

Care must be taken when removing reservoirs that they are not thrown down or roughly handled. To protect them from jar, three 4-inch tarred rope grummets will be placed on the reservoirs; and in hot climates, wadmiltilts, or such other suitable covering as may be available, will be used, when required, to protect them from the rays of the sun.

SEPARATOR, AIR PUMP, MARK I.

(*Plate XLI.*)

The separator is used to separate the moisture from the air during the process of pumping into the reservoir. It consists of a copper tube, $1\frac{7}{8}$ inches in diameter and 3 feet long, screwed at both ends. At one end of the copper tube a wrought iron head (*c*) is fitted, furnished with inlet and outlet valves of gunmetal, and a $\frac{1}{4}$-inch copper pipe (*d*), which carries the air and water in a downward direction into the separator. At the other end of the copper tube is a wrought iron foot which is fitted with a drain-cock (*e*) of gunmetal. The separator is connected up between the pump and the reservoir to be charged, and the moisture of the air, while passing through the copper tube, falls to the bottom and is blown off from time to time during the operation through the drain-cock. When the separator is used, it must be always fixed in a vertical position, the inlet and outlet valves being at the top.

CONNECTION, PRESSURE GAUGES, MARK I.

(*Plate XLII.*)

The pressure gauge required is attached to the recoil cylinder of the mounting by the intervention of a three-way connection, one opening of which (*a*) screws into the filling valve, the opposite one (*b*), takes the pump tube, and the centre (*c*) the gauge. (When the gauge is not on this opening it is closed by the closing plug (*f*), the nut (*h*) fitting either the plug (*f*) or the foot of the gauge.) There is a cut-off

(*d*) worked by the spindle (*e*), which closes the way to the gauge, while leaving the passage free between pump and cylinder. The way to the gauge should not be left open while pumping or firing is going on, as the gauge is liable to suffer. When it is desired to leave the gauge on, and detach the pump pipe, the bared nozzle of the connection is closed by a blank cap (with leather washer), supplied (*g*).

In connecting the gauge it is not necessary that it should be vertical; it may be used in any position.

For spanners, *see* "Gauges, pressure."

CONNECTION, FOUR-WAY, AIR PUMP.

(*Plate XLIII.*)

Mark I four-way connection is made of gunmetal, and has a plug, lead washer, loop, and chain; four caps, each with leather disc, loop, and chain.

The connection is to admit of the use of more than one pump when charging the recoil cylinders of hydro-pneumatic mountings with fluid and compressed air; it has four unions, three of which are available for the connecting pipes of three pumps, and the fourth for the pipe leading to the recoil cylinder. If less than three pumps are employed, caps are placed over the unions not in use. It is not used with the "Pump, air or gas."

By working the pumps simultaneously, the charging of the cylinders is greatly accelerated.

The connection will be allowed in the proportion of "1 per work" in which hydro-pneumatic carriages are located.

GAUGES, PRESSURE.

(*Plate XLIV.*)

The gauges generally consist of a metal cylinder (*a*) containing the mechanism, which is closed in by a 6-inch dial (*b*), and a sheet steel plate at the back.

The mechanism consists of a metal bearing which is attached to the cylinder and dial plate; that part of the bearing which is attached to the dial plate is flattened and suitable bearings are secured to it for the spindle of the dial indicator, and for a crank (*c*) through which the indicator is actuated, while that part (*d*) of the bearing which is attached to the side of the cylinder has a channel which is in continuation of the connection (*e*) (for "Connection, pressure gauge" or "Connection, four-way, air pump"); in one side of this channel is a hole in which one end of a short phosphor bronze tube (*f*) (No. 4 gauge has steel tubing, owing to the higher pressure it is subjected to) is inserted and

soldered, the tube is slightly flexible, and is bent partly round the cylinder, its opposite end being closed with a cap (*g*) to which is attached a crank arrangement working on a pivot (*h*), and which has an adjustable arm attached to a segmental rack (*i*) in gear with a pinion on the spindle of the dial indicator (*y*).

Each instrument is provided with a dial indicator stop, fixed either on the dial or within, against some part of the mechanism.

There are four patterns, and each one is constructed to register the hydraulic pressure per square inch, which, together with their respective services, are as follows :—

No. 1 (Mark I) from 0 to 350 lb. per square inch :—For carriages, garrison, barbette, B.L. 9·2-inch, Marks IV and V, and 10-inch, Mark IV.

No. 2 (Mark I) for 350 to 1,000 lb. per square inch :—For carriages, garrison, disappearing, B.L. 6-inch, 9·2-inch, and 10-inch (*carriage up*) ; R.M.L. high angle ; also compressed air reservoirs.

No. 3 (Mark I) for 1,000 to 2,200 lb. per square inch :—For carriages, garrison, disappearing, B.L. 6-inch, 9·2-inch, and 10-inch (*carriage down*) ; also compressed air reservoirs.

No. 4 (Mark I) for 1,800 to 4,500 lb. per square inch :—For pump, testing compressed air reservoirs.

Action.—On liquid pressure entering the bent tube within the gauge, it gradually inclines the tube outwards, thus the dial indicator is actuated through the pivoted crank and segmental rack. When the pressure is removed from the instrument, the dial indicator returns to stop at the normal position.

The following steel spanners are used with the above gauges :—

Spanners :—

No. 103, for gauges, pressure, Nos. 1 to 4 ; also pressure gauge connection.

No. 104, for connection, pressure gauges, and filling valves H.P. carriages.

GAUGE, PRESSURE, DEAD WEIGHT TESTING.

Mark II.

(*Plate XLV.*)

This is issued to test the accuracy of the gauges, pressure, Nos. 1 to 3 or records up to 2,000 lb. per square inch.

The gauge to be tested is screwed on to the connection at one end, and fluid pressure applied by means of a plunger (*e*), driven by a hand-wheel (*f*) at the other end. A safety valve, weighted by means of a lever (*g*), which supports marked weights (*h*), rises when the pressure per square inch marked on the weights is obtained ; the gauge (*c*) should then show this pressure. The lever bed plate, &c., for the weights, counts for 200 lb. (per square inch) in addition to the weights supplied.

The liquid employed is the same as that used in H.P. cylinders, and it is poured into the reservoir (*i*) from time to time as required. There are two cut-off valves (*k*) and (*l*), one to the gauge and one to the reservoir. As the stroke of the plunger is small, the liquid has to be drawn from time to time from the reservoir without losing the pressure, and this is effected by the judicious manipulation of these valves, the gauge being cut off by screwing up the valve (*k*) and the reservoir connected when the plunger is being withdrawn, and the reservoir cut off by the valve (*l*) and gauge connected when the plunger is being screwed in. The reservoir should be kept covered while in use, to prevent dust getting into the liquid.

Care should be taken not to shake the instrument while the pressure is on, as it is liable to make the safety valve act prematurely, and so vitiate the results.

There are several leather joints and packings which require attention. Spare leathers are issued in a small tin box in the case, together with the necessary spanners (Nos. 101 and 102), and special instructions as to packing the piston, &c.

NOTE.—This Mark will be obsolete when Mark III is provided.

MARK III.

(Plate XLVI.)

With this design of gauge "Gauges, pressure, Nos. 1 to 4" can be tested, or pressures varying from 0 to 4,000 lb. per square inch. Plungers of varying areas are provided, so that the same set of weights may be made to give four different series (one series for each plunger) of pressures per square inch.

The gauge consists principally of two hollow cylinders directly connected to each other, one vertical (*a*) and the other horizontal (*b*), a ram (*c*), four plungers (*d*, *e*, *f*, *g*), reservoir (*h*, with cover, *s*), carrier (*i*), weights (A to G), intake valve (*l*), and union connection (*m*).

The horizontal cylinder is fitted with a screwed ram, which is actuated by a cross handle (*n*), leakage being prevented by a gland with U leather. The hole through the vertical cylinder is of four different diameters to suit the plungers, each one being of twice the area of the one next below. The reservoir surrounds the lower portion of the vertical cylinder, and the screwed intake valve (*l*) controls the admission of oil from the reservoir to the ram chamber (*k*) and on the gauge through the hole (*o*).

The four plungers provided are of four different lengths, one for each section of the vertical cylinder, in which it accurately fits; each is coned at the top, and provided with a cross-piece for the attachment of the carrier.

The carrier (*i*) is in the form of a hollow cylinder, open at the bottom and closed at the top by a cap, the interior being coned so as to centre itself on the top of the plunger, and slotted to engage with the cross-piece of the plunger, so that upon the carrier being rotated, the motion may be conveyed to the plunger. The lower portion of the carrier is flanged to receive the weights.

The weights are in the form of discs, each with a central hole to suit the carrier; they consist of the following:—

Weights marked.	No.	Proportional weight.
A	1	1
B	1	2
C	1	3
D	1	4
E	1	10
F	8	20
G	1	15

The arrangement of the weights in size permits of a variation of—

2½ lb. per square inch from 12½ lb. (weight of carrier and plunger) per sq. in. to 500 lb.

5 ,, ,, 25 ,, ,, 1,000 ,,

10 ,, ,, 50 ,, ,, 2,000 ,,

20 ,, ,, 100 ,, ,, 4,000 ,,

A suitable connection (*m*) is provided for attaching the pressure gauge to be tested, and to permit of the dial facing the operator.

The gauge is secured to a base board suitable for fixing to a bench. A wood cover and two spanners are provided.

Instruction for Filling.

The ram being home, remove the weights, carrier and plunger, and open the intake valve; pour oil into the vertical cylinder, and withdraw the ram *slowly* (maintaining the supply of oil) until a space of about 9 *inches* of the ram is visible; continue the supply of oil until it appears in the reservoir and connection for pressure gauge; close intake valve and fill the vertical cylinder; force the ram in to engage with the screwed portion of the horizontal cylinder, and screw in till only a space of 4½ *inches* is visible; replace plunger, carrier and the weights required (*see* table).

This operation should be performed *slowly* and *carefully*, to allow time for the escape of air as far as possible.

Instructions for Testing.

When about to screw ram home for pressure, the carrier should be *slowly* rotated and the motion maintained till the weights are lifted, when the gauge should register the required pressure.

When the ram is screwed home, open intake valve, and *slowly* withdraw ram till a space of 4½ *inches* is visible, then close intake valve, and proceed as before.

To clean out.—Unscrew gland and end plug, remove ram and all packings, and clean out with paraffin.

Contents.—About ½ pint of "oil, lubricating, for cylinders of gas and oil engines" is required to charge the gauge.

Spanners.

Spanner, No. 239, is used for gland, pressure cock, intake valve, and small connecting union.

Spanner, No. 240, for union, connecting large, and ram gland.

Value of weights in lbs. per square inch in relation to the plunger used.

Weights.	Large plunger.	Large intermediate plunger	Small intermediate plunger.	Small plunger.
A	2½	5	10	20
B	5	10	20	40
C	7½	15	30	60
D	10	20	40	80
E	25	50	100	200
F	50	100	200	400
G	37½	75	150	300
x	12½	25	50	100

x = lb. per square inch due to carrier and plunger.

Tables showing the arrangement of weights necessary to obtain a given pressure in lbs. per square inch.

Each table is compiled for use with the particular pressure gauge and plunger quoted.

The lbs. pressure per square inch due to the weight of the plunger and carrier (which is represented by x in the Table) must always be included when calculating the weights.

TABLE 1.—PRESSURE GAUGE NO. 1.

Plunger: Large. $x = 12\frac{1}{2}$ *lbs. per square inch.*

Weights. lbs. per square inch.

x 12½	A 2½	B 5	C 7½	D 10	E 25	G 37½	— —	F 50	2F 100	3F 150	4F 200	5F 250	6F 300
—	A	—	—	—	—	—	15	65	115	165	215	265	315
—	—	—	C	—	—	—	20	70	120	170	220	270	320
—	—	B	C	—	—	—	25	75	125	175	225	275	325
—	—	—	C	D	—	—	30	80	130	180	230	280	330
—	—	B	C	D	—	—	35	85	135	185	235	285	335
—	A	—	—	—	E	—	40	90	140	190	240	290	340
—	—	—	C	—	E	—	45	95	145	195	245	295	345
—	—	—	—	—	—	G	50	100	150	200	250	300	350
—	—	B	—	—	—	G	55	105	155	205	255	305	—
—	—	—	—	D	—	G	60	110	160	210	260	310	—

Table 2.—Pressure Gauge No. 2.

Plunger: Large, intermediate. $x = 25$ *lbs. per square inch.*

Weights. lbs. per square inch.													
x 25	A 5	B 10	C 15	D 20	E 50	G 75	—	3F 300	4F 400	5F 500	6F 600	7F 700	8F 800
—	A	—	—	D	—	—	—	350	450	550	650	750	850
—	A	B	—	D	—	—	—	360	460	560	660	760	860
—	—	B	C	D	—	—	—	370	470	570	670	770	870
—	A	—	—	—	E	—	—	380	480	580	680	780	880
—	A	B	—	—	E	—	—	390	490	590	690	790	890
—	—	—	—	—	—	G	—	400	500	600	700	800	900
—	—	B	—	—	—	G	—	410	510	610	710	810	910
—	—	—	—	D	—	G	—	420	520	620	720	820	920
—	—	B	—	D	—	G	—	430	530	630	730	830	930
—	A	—	C	D	—	G	—	440	540	640	740	840	940
—	—	—	—	—	E	G	—	—	—	—	—	—	950
—	—	B	—	—	E	G	—	—	—	—	—	—	960
—	—	—	—	D	E	G	—	—	—	—	—	—	970
—	—	B	—	D	E	G	—	—	—	—	—	—	980
—	A	—	C	D	E	G	—	—	—	—	—	—	990
—	A	B	C	D	E	G	—	—	—	—	—	—	1000

Table 3.—Gauge Pressure No. 3.

Plunger: Intermediate Small. $x = 50$ *lbs. per square inch.*

Weights.											
x 50	A 10	B 20	C 30	D 40	E 100	G 150	4F 800	5F 1000	6F 1200	7F 1400	8F 1600
—	—	—	—	—	—	G	1000	—	—	—	—
—	—	B	C	—	—	G	1050	—	—	—	—
—	—	B	C	—	—	—	—	1100	1300	1500	1700
—	—	—	—	—	E	—	—	1150	1350	1550	1750
—	—	B	C	—	E	—	—	1200	1400	1600	1800
—	—	B	C	—	—	G	—	1250	1450	1650	1850
—	—	—	—	—	E	G	—	—	—	—	1900
—	—	B	C	—	E	G	—	—	—	—	1950
—	A	B	C	D	E	G	—	—	—	—	2000

TABLE 4.—GAUGE PRESSURE No. 3.*

Plunger: Small. $x = 100$ *lbs. per square inch.*

Weights.										
x 100	A 20	B 40	C 60	D 80	E 200	G 300	2F 800	3F 1200	4F 1600	5F 2000
—	A	—	—	D	—	—	1000	1400	1800	2200
—	—	—	—	—	E	—	1100	1500	1900	—
—	—	—	—	—	—	G	1200	1600	2000	—
—	A	—	—	D	—	G	1300	1700	2100	—

TABLE 5.—GAUGE PRESSURE No. 4.

Plunger: Small. $x = 100$ *lbs. per square inch.*

Weights.										
x 100	A 20	B 40	C 60	D 80	E 200	G 300	4F 1600	6F 2400	7F 2800	8F 3200
—	—	—	—	—	—	—	—	2500	—	—
—	A	—	—	D	—	—	1800	—	3000	—
—	A	—	—	D	E	—	2000	—	—	—
—	—	—	—	—	E	—	—	—	—	3500
—	A	B	C	D	E	G	—	—	—	4000

Instructions for using the Tables.

Having found the number in the table representing the lbs. per square inch required, place the weight or weights shown at the head of the column (in which the number occurs) on the carrier, together with the weight or weights indicated by the letters on the same line to the left of the table.

Example.—Required the necessary weights to indicate 285 lbs. per square inch.

By reference to the Table 1, the following weights are required on the Carrier:—$5F + B + C + D + x = 5 \times 50 + 5 + 7\frac{1}{2} + 10 + 12\frac{1}{2} = 285$.

* Two tables are given for No. 3 Pressure Gauge. Table No. 3 shows a constant variation of 50 lbs. per square inch up to 2,000 lbs., and Table 4 shows a constant variation of 100 lbs. up to 2,200 lbs.

AMMUNITION.

See "Equipment Regulations for Actual Allowance."

CARTRIDGES.

(*Plates XLVII to L.*)

Nature.	When filled.	
	Length not to exceed	Diameter not to exceed
	ins.	ins.
Cartridges, B.L., 10-inch—		
63 lb. prism[1] brown, ¼ charge	12·25	12·0
38 lb. cordite, size 30, ½ „	23·25	8·25 large end. 6·75 small end.
	over all	body. base.
Cartridges, aiming rifle electric, Mks. II and	5·0	1·098 1·219
Cartridges, aiming rifle percussion	5·2	1·1 1·226
Cartridges, aiming tube..	0·87	0·355

CARTRIDGE, B.L. 10-INCH, 63 LB. PRISM[1] BROWN | C | .

The cartridge is made of No. 3 class silk cloth; the body is prismatic, with polygonal ends shaped to fit the form of the built-up prisms. In the centre of each end there is a hole 4 inches is diameter, covered with silk netting, over which the shalloon disc is fastened by shellac; a piece of 0·65 inch silk braid is sewn on to each shalloon disc for the purpose of tearing it off before loading.

The powder (*see* above table) is built up in twelve layers, consisting of eleven layers having fifty-five prisms each and one layer having such convenient number as will bring the total weight up to 63 lb., but the top layer should not contain less than 42 prisms, one or more complete vertical tiers being removed, if necessary, to make up the requisite number in the top layer. The vertical tiers removed should be those outer ones which will least alter the shape of the cartridge.

In the centre of both top and bottom tiers seven prisms of Prism[1] black powder are inserted, to facilitate ignition.

Two beckets, made of silk braid 1½ inches wide, are sewn on the top and bottom for the purpose of lifting the cartridge. There are also eight 0·65-inch silk braid hoops, which keep it in form, thus making a good firm cartridge.

Packed 1 in a cylinder, cartridge, No. 5, or 5A.

CARTRIDGE, B.L. 10-INCH, 38 LB., CORDITE, SIZE 30 | C |.

Mark I.—This cartridge is made of No. 2 class silk cloth, with six hoops of 0·65-inch silk braid. There are two lifting beckets of 1-inch

braid at each end. The charge of cordite is built up, tied with sewing silk, and placed in the bag, an annular space being left at one end of each charge for a primer of 8 oz. R.F.G.[2] powder, which is contained in a ring formed by silk cloth and shalloon sewn together (the front half cloth and the rear shalloon, the cloth being secured to the cartridge by stitching), and stitched across in four places, each compartment holding 2 oz. of powder. The cartridge is closed by silk netting,* silk cloth, and a millboard disc; the silk netting and silk cloth disc are sewn to the bag; to the millboard disc is attached a silk cloth disc, both being ripped off before loading; a red binding loop, marked "Tear-off," being attached for the purpose. The primed end of the cartridge should be placed next to the vent in loading.

There is a Mark I cartridge special to the colony of Victoria; it is similar to the Mark III cartridge hereafter described, excepting that it is cylindrical in shape with an over all diameter not exceeding 9·75 inches.

Mark II cartridge is similar to Mark III, except that the silk braid loop for central becket is less strongly attached to the bottom of cartridge, and the primer, which is contained in a ring, as for the Mark I cartridge. Only a few of this Mark were issued.

Mark III.—This differs from Mark I in the primer and in having a central hole for a lifting becket. The primer of 8 oz. R.F.G.[2] or new blank F.G. powder is formed by a disc of shalloon sewn flat to end of the bag, and No. 1 class silk cloth, which is secured to the shalloon disc, the two being stitched across in four places, each compartment holding 2 oz. of powder. The central lifting becket is of silk cord, it is passed through the central hole in the cartridge, and then tied to a silk braid loop, secured to two silk cloth discs in the small end of the cartridge.

Packed 1 in a cylinder, cartridge No. 20.

Cartridges, B.L. Drill, 10-inch | C | .

Dummy cartridges are issued for drill purposes.

The 63-lb. Mark I drill cartridge is made of wood, weighted with cast iron, covered with raw hide, fitted with a rope handle at each end, and is of the same weight and dimensions as the Service prism cartridge.

The 63-lb. Mark II drill cartridge differs from Mark I in being weighted with lead instead of cast iron.

The 38-lb. Mark I drill cartridge is made up of similar materials to those for the Mark II 63-lb. cartridge. A leather lifting becket is fitted at the small end, and a leather lifting loop at the large end, both of Preller's lace. The cartridge is of the same weight, shape, and dimensions as the Service cordite cartridge.

Securing Cartridge Cylinders; Stacking, &c.

See "Regulations for Care and Preservation of War Matériel, Magazines, &c.

* The silk netting is now omitted in making up cordite cartridges.

Cartridges for Aiming Rifle and Aiming Tube.

Cartridges, Aiming-Rifle, 1-inch, Electric.

The Mark II case is of solid-drawn brass, having in its base an electric primer made of three tubes, which fit into one another, the central and intermediate ones being insulated from one another by means of goldbeater skin round the body of the former, and a vulcanized fibre washer under its head. A platinum-silver bridge, round which is a tuft of guncotton, connects the ends of the central and intermediate tubes, the space beyond the bridge in the intermediate and outer tubes being filled with fine grain powder. A conical brass plug closes the mouth of the inner tube to prevent the escape of gas. The head of the inner tube is raised in the centre to form a contact point, and round it is a ring of insulating material. The case is charged with 400 grains R.F.G.[2] powder, over which are placed wads, and a pointed bullet of hardened lead, secured to the case as for the percussion cartridge.

Mark IV M, Mark IV, KN, differ from Mark II in having an electric primer, consisting of a brass outer tube, two ebonite insulating plugs, and a brass contact pin. An aridio-platinum wire bridge is soldered one end to the point of the contact pin, the other end to the circumference of the tube.

In order to facilitate identification of the pattern of primer used in the manufacture of Mark IV cartridges, the letters "M" or "KN" are, in manufacture, stamped on the cartridge and printed on the wrapper after the numeral, to indicate that the primers are made, respectively, to the Morris, or King's Norton Company's pattern.

Packing, same as the 1-inch percussion cartridge.

Cartridge, Aiming-Rifle, 1-inch, Percussion.

Mark I: the case is of solid drawn brass, having the cap, chamber, and anvil formed in the base; the cap is double, the outer of brass, the inner of copper. Three fire holes in the cap chamber enable the flash to pass from the cap to the charge. The charge consists of 465 grains of M.G.[1] powder, or 400 grains R.F.G.[2], on top of which are placed wads and the bullet. The bullet is of lead, pointed; it is secured to the case by indenting the latter in three places into the lower of three cannelures, but in the latest manufacture the case is coned for the purpose of securing the bullet.

Packed 96 in a "Box, ammunition, S.A., G.S.," in bundles of 12.

Weight of box filled about 97½ lb.

Cartridges, Aiming-Tube.

Mark I case is of solid-drawn brass, with a cap chamber and anvil in the base; two fire holes in the anvil allow the flash to pass from the cap to the charge, which is 3¼ grains "Curtis and Harvey's Diamond, No. 2" powder; over it are wads and a bullet of pure lead.

Mark II differs in the arrangement of the wads.

Packed 100 in a cardboard box, and issued, usually, 10,000 in a tin-lined box.

PROJECTILES.

(*Plates LI to LIV.*)

Nature.	Mark.	Bursting charge.		Total weight, filled and fuzed in the case of shell.
		Weight.	Powder.	
		lb. oz.		lb.
Shell, B.L., 10-inch—				
Armour-piercing	1, II	25 0	{P. & F.G.†	500
Common { cast steel	{I, I* and II}	37 12	„	500
Common { cast steel	I‡	34 0	„	450
Common { lyddite	I, II	46 0	Lyddite	500
Shrapnel	III	1 9	R.F.G.[2]	500
Shell, practice, common, pointed, B.L., 10-inch	I, II	—	—	500
Shot, paper, empty—				
B.L., 10-inch (¼ charge) { front	I-IV	—	—	125
B.L., 10-inch (¼ charge) { rear	I-IV	—	—	125

† In the proportion of 4 lb. P. to 10 oz. F.G.
‡ This shell is special to the Colony of Victoria.

SHELL, B.L., ARMOUR-PIERCING, 10-INCH | C | .

(*Plate LI.*)

Mark I A.P. shell differs from Mark II in the form of the groove for the driving band: the groove is undercut, but without waved ribs.

Mark II is of forged or cast steel without bands, the head is brought to a point, which is hardened for the penetration of armour plate, and is struck with a radius of two diameters. The walls are not less than 1·74 inch thick. The base is rounded to a radius of 0·2 inch; and is usually closed with a steel bush, which is screwed in as tightly as possible and the joint riveted up; this bush is tapped to take the "Fuze, percussion, base, large, No. 11." A groove is prepared for the driving band at 1·21 inch from the base; the ribs of the groove are waved, which may have three chisel cuts made across them; with these waved ribs the driving band is prevented from turning and less liable to strip off. The total length of the shell is left to the maker.

The driving band is of the gas-check design; it is of copper, with one cannelure, pressed into the groove prepared for it, to impart rotation to the shell; the front slope of the gas check portion of the band is serrated, so as to grip in the bore of the gun when loading.

The inside of the shell is lacquered, and to further prevent premature explosion when the gun is fired from the powder setting back in the shell, the bursting charge is contained in a dowlas bag, *see* page 104.

For bursting charge, *see* Table.

Shell, B.L., Common, 10-inch, Cast Steel | C | .

(*Plate LII.*)

Mark I shell is made of steel, cast with bands, with a diameter of 9·95 inches. The base of the shell is rounded with a radius of 0·2 inch. The head is struck with a radius of two diameters, the point being truncated, screwed, and fitted with a gunmetal bush, tapped to G.S. fuze hole gauge. The interior of the shell is lacquered.

A groove is turned in the body near the base, into which is pressed a copper driving band, turned to a diameter of 10·145 inches, to impart rotation to the shell. The front slope of the driving band is roughened to prevent the shell slipping back into the chamber when loading at elevation, and the cannelures are undercut.

A hole is bored in the side of the shell, at the centre of gravity, and screwed to receive an eyebolt for lifting purposes, so that when lifted the shell will be horizontal.

The base of the shell is bored and screwed 9 threads per inch, left hand, and may be fitted with a gunmetal adapter at the option of the manufacturer, the joint being made gas-tight by a small lead ring. The adapter or shell is screwed inside 9 threads per inch, left hand, to take a gunmetal plug having a square keyhole in the head, and a lead washer under it to form a gas-tight joint.

Mark I* common shell differs from Mark I in being fitted with "driving band with gas check." A second star (*) after the numeral indicates that an improved form of driving band has been fitted to the shell.

Mark II.—This shell differs from the previous Marks principally in being fitted with an adapter in the nose to facilitate filling and emptying, and the manner of closing the base. The adapter is screwed into the nose of the shell and further secured by a steel screw, the joint round the flange of the adapter and shell being closed by an india-rubber or gutta-percha ring; it is tapped to G.S. fuze hole gauge and fitted with two keyholes for removing it. For convenience of manufacture the shell is made with a hole in the base, closed with a plug, which is tightly screwed in and rivetted over the joint. The shell is fitted with the Vavasseur driving band, with gas check; the groove for driving band being undercut to prevent the band stripping off.

Shell, B.L., Common Lyddite, 10-inch | L | .

(*Plate LIII.*)

Mark I common lyddite shell is the same as Mark II, with the exception of the ribs of the groove for the driving band, which are not waved.

Mark II shell is made of forged steel, cast with bands, and 3·62 calibres long. The walls are not less than 1·645 inch thick. The base is solid and rounded to a radius of 0·2 inch; the head is struck with a radius of two diameters, the point being truncated, and fitted with a gunmetal bush, which is tapped to G.S. fuze hole gauge. A groove is turned in the body of the shell as for the Mark II A.P. shell previously described, for the driving band, which is also similar to the band for that shell.

A lifting hole is provided at the centre of gravity as for the common shell.

The interior of the shell is varnished, and it is filled with lyddite (*see* Table), with a 4½ oz. picric powder Mark I exploder and a Mark II primer of 8 drams R.F.G.[2] powder; the exploder and primer are each contained in a shalloon bag, and both are enclosed in a waterproofed paper cylinder 16·1-inch long, the chokes of both bags being placed downwards in the cylinder; the latter is closed at the top with an aluminium cap, which is secured with shellac cement.

The shell is secured with either a Mark I plug and kit plaister, or Marks I* or II special plug with a leather washer under the shoulder of the plug; three punch stabs are made in the head of the plug and bush, thus further securing the former.

Lyddite shell are issued filled, and no preparation is required before loading them in the gun other than removing the kit plaister (when used) and plug, and screwing in the impact fuze.

Shell, B.L., Shrapnel, 10-inch, Cast Steel | C | .

(*Plate LIIIa.*)

Mark III shell is made of cast steel, with a solid base, and fitted with a driving band, as described for the Mark II, A.P., shell. The base of the interior is contracted to form a chamber for the bursting charge, which is contained in a tin cup, to prevent loss and to guard against possible prematures from the roughness of the shell. Over the cup is fitted a steel disc or diaphragm, having a hole in the centre for a piece of gas-pipe which is screwed into it and extends to the fuze socket. The head of the shell is a thin cap of steel fitting over a block of wood, which is bored out in the centre to take the fuze socket; it is secured to the walls by rivets and twisting pins, soldered over. The upper part of this socket is tapped inside to the G.S. fuze-hole gauge, and in the lower part to receive the primer. The shell is lined with brown paper and filled with about 466 sand shot (4 oz.) which are packed in resin, the whole being covered over by a felt washer.

Drill and Practice Projectiles.

Shell, B.L., Drill, 10-inch | L | .

This is of cast iron, fitted with two gunmetal bands to prevent injury to the rifling in loading and unloading. The nose is bushed the same as a common shell. The base is fitted with a large hollowed and flanged plug of gunmetal, with a crossbar for the hook of the extractor, and a gunmetal ring with a groove to take a rope grummet, which prevents the shell being rammed too far home. It is weighted up with about 23½ lb. of sand to an average weight of 500 lb.

When difficulty is experienced in using the shell with the earlier patterns of loading tray, the following course will be taken :—

Unscrew the gunmetal base ring of the shell one turn, well grease the grummet, and then carefully hammer it down all round with a mallet until it is sufficiently reduced in diameter to admit of the shell being easily loaded.

The base ring can be gradually screwed up as the grummet wears.

Shell, Practice, Common Pointed, B.L., 10-inch | C | .

Mark I practice shell differs from Mark II in the form of the lower part or groove of the driving band.

Mark II is generally similar to the service cast steel common shell, but it is of iron, and the head is brought to a point; the walls are thicker and the base is fitted with the large base plug. The groove for the driving band is undercut.

Shells of this description are issued unlacquered, filled with salt cake (commercial dried sodium sulphate, 13 lb. 4 oz.). They are painted with a yellow band (denoting practice) round the body, and stamped with the letter "P" on the base.

Shot, Paper, Empty, B.L., 10-inch { Front | L | . Rear | L | .

(*Plate LIV.*)

Mark I paper shot is made of brown paper, choked to elm ends, with a filling hole in the top, which is closed with a wood plug.

Mark II is entirely of papier-mâchê, and the filling hole in one end is closed with a cork bung.

Mark III is similar to Mark II, but it is made of wood pulp.

Mark IV consists of pressed wood pulp, having the ends secured to the cylinders with oak pins. In one end there is a filling hole, which is closed with a bung. The "Front" portions are made cylindrical, the "Rear" portion with an enlargement at one end, so that this increased diameter will stop against the commencement of the bore in ramming home and prevent over ramming. They are painted black.

There are three "front" and one "rear" portion to a round, which are issued empty, and when required for use are filled with small shot (Nos. 1 to 5) and sawdust, to 125 lb. each ¼ portion. The earlier marks, which are larger, being formerly two per round, are now adjusted to 125 lb. each by using a larger quantity of sawdust to waste shot in filling.

Paper shot are stencilled "Not to be fired with cordite."

As they break up on firing, the small shot travel but a short distance (about 200 yards), while the effect, for purposes of testing recoil, &c., is practically the same as that obtained with the service projectile. They will therefore be issued for use in time of peace, where the use of the service projectile would be dangerous or inconvenient.

There will, no doubt, be emplacements from which, owing to the close vicinity of houses, it may be undesirable to use these shot in the normal line of fire. In these cases it will be often found possible, owing to the very short range of the paper shot, to find sufficient space to the right or left of the regular range to carry out such test practice as may be required.

When using these shot the gun should be run up carefully and slowly.

Bags, Burster, B.L., 10-inch { Armour-Piercing. / Common, Cast Steel.

These are for holding the bursting charges of armour-piercing and common shells, to prevent premature explosion through friction when the powder sets back on the shock of discharge. The bags are made of dowlas, with shoulder and neck of shalloon, and choked with twine, the shape corresponding with the interior walls of the shell.

Plugs, Base, Shell { No. 1. / No. 4.

No. 1 base plug is made of gunmetal, and is of the same external shape as the fuze, but with a square keyhole in the head to take the "Wrench, base, plug."

The plug is used for filled shells taking the large base fuze, B.L. or Q.F. 6-inch and above.

No. 4 base plug is of gunmetal, made specially for empty pointed shells, B.L., Q.F. or Q.F.C. 6-inch and above, and must not be used in shells filled with powder.

Protector, Projectile, No. 5.

This protector is for use with the B.L. 10-inch or 11-inch R.M.L. pointed projectiles. It consists of an elm block which is recessed to receive the point of the projectile, and fitted with an iron or steel band to receive the screwed ends of an adjustable band of hoop iron; the latter band is intwo pieces, bent and riveted at the bottom to a dish shaped plate which fits over the base of the projectile.

It can be lengthened or shortened to a certain extent by means of the hoop band, by engaging the studs in corresponding slots, and then finally tightening up on the projectile with the nuts on the screwed portion of the band.

Extractor, Drill Shell, No. 2 | L | .

This is of steel, with a wood stave, the outer end of which is grooved spirally to prevent the hands slipping; the steel portion is formed to hook on the cross-bar of the drill shell base plug.

Total length, 8 feet.

Strips, Augmenting, B.L., 10-inch.

Description.

Augmenting strips are intended to be used with B.L. projectiles in cases where the rifling of the gun has, owing to firing, become so worn that the gun ceases to properly rotate its projectiles. They are not to be used with projectiles having the gas check driving band, and the use of the strip is restricted to projectiles having the broad "Vavasseur" driving band. The strips are of copper, of even section throughout, and grooved on one side. The lengths of the stripe vary with the calibre, and they are marked for the nature of the gun with which they are intended to be used.

Method of Insertion.

The top cannelure in the driving band is to be undercut all round on both sides by means of a special chisel supplied for the purpose. The augmenting strip is then inserted in the cannelure, grooved side of strip inwards, and lightly hammered until the two tongues of metal formed by the groove on the inner side of the strip are dove-tailed into the undercuts in the cannelure, which will in future be undercut during manufacture, and stamped U, and no preparation for the insertion of augmenting strips will be necessary.

If the gun is very much worn, and one strip is found insufficient to impart the proper rotation, a second may be inserted in a lower cannelure in addition.

The number of rounds which may be fired from the 10-inch B.L. gun before augmenting strips must be used is (probably) 162.

As regards wear of bore, reduced charges may be reckoned to have one-quarter the effect of full charges.

FIXING FUZES AND PLUGS, DISTINGUISHING MARKS, TRANSPORT, &C., OF SHELLS.

See "Regulations for Care and Preservation of War Matériel and Magazines."

FUZES.

(Plates LV to LVIII.)

Fuze, percussion .. .. { base, large, No. 11, Marks I*, II*, III, IV.
direct action { with plug No. 3.
impact, No. 13.

Fuze, time and percussion { middle, No. 54.
No. 62.

Fuzes, drill, percussion .. { base, large, No. 11.
D.A. { with cap, No. 1.
impact, No. 13.
T and P, middle, No. 54.

The actual equipment allowed of the above will be found in the Equipment Regulations.

The following is a description of the fuzes :—

FUZE, PERCUSSION, BASE, LARGE, No. 11.

(Plate LV.)

This fuze is for use in cast steel common shell having pointed heads.

Some of the earlier Marks of this fuze (Mark II is retained for use with common pointed shell R.M.L., 9-inch, high-angle guns) have been converted to Mark IV design by being fitted with the perforated steel protecting plate, which in this case is screwed into the base of the fuze,

and is prevented from turning by three centre punch dabs. When altered a star (*) is added to the numeral, thus, I*, II*.

Mark III (of which only a certain number were made) differs from Mark IV fuze principally in the centrifugal bolt which has less protrusion.

Mark IV consists of the following parts, viz. :—Body, needle, pellet, centrifugal bolt, pressure plate with spindle and nut, perforated protecting plate, screwed cap with detonator and plug, phosphor-bronze spring, brass spring, and four brass screws.

The body of the fuze is of manganese-bronze, screwed outside (left hand) to fit the shell. The pressure plate is of copper, and is spun into the base of the fuze; it carries a spindle which retains the centrifugal bolt in the needle pellet by engaging in a slot in the latter until the pressure plate is blown in. The base of the body is recessed to admit of the pressure plate being forced in by the gas pressure when the gun is fired. The protecting plate is of steel and perforated with eight holes to allow the pressure plate to be crushed in; it is spun into the base of the fuze, covering the pressure plate.

The needle pellet is of gunmetal, and has a screwed recess on top for the needle plug, and a hole bored in it, at right angles to the axis, to take the centrifugal bolt, the head of which engages into a recess in the side of the body, and is kept in that position by a spiral brass spring in the opposite side and by the spindle of the pressure plate. The needle pellet is prevented from working forward in flight by a spiral spring of phosphor-bronze.

The detonator is spun into a recess in the screwed cap, and communicates by six fire holes with the magazines, containing a compressed pellet of R.F.G.^{2} powder between the cap and the plug.

Action.—On discharge the pressure of the gas crushes in the pressure plate, causing the spindle to release the centrifugal bolt. The rotation of the shell causes the centrifugal bolt to be spun out, compressing the spring in rear, and leaving the needle pellet free to move forward on impact; when the needle strikes the detonator the flash ignites the powder pellet in the magazine and explodes the shell.

The head is painted red.

Weight .. ..2 lbs. 8 oz.

Note.—Shells fitted with this fuze must never be placed point to base.

Fuze, Percussion, Direct Action, with Plug, No. 3.

(*Plate LVI.*)

The Mark III fuze consists of the following principal metal parts, viz. :—Body, safety plug, screw collar, needle disc and steel needle, screw plug for needle disc, and bottom screw plug.

The fuze is made of an alloy resembling gunmetal, with the exception of the steel needle, copper disc, and a few minor portions.

The *body* is threaded throughout on the exterior to the general service taper and pitch, and can be screwed into the shell to admit the naval wad being placed over it. The lower part is hollowed out to receive a blowing charge of 75 grains pistol or R.F.G.^{2} powder. The upper portion of the body is bored out to receive the safety plug, screw plug for needle disc, and screw collar; there is a recess below these to receive the detonating composition, consisting of 3½ grains of cap composition, varnished and covered with a brass disc, having

on the top of the brass disc a copper washer kept in position by being spun over. This washer has a central hole, which was formerly 0·2 inch diameter, but from the 192nd thousand it is 0·3 inch diameter. At the bottom of this recess there are nine conical fire holes, to allow the flash of the detonating composition to pass to the powder. These conical holes are filled with mealed powder paste, and covered on the underside by a disc of fine white paper, and on the upper side by a tin-foil disc (subsequent to 27th June, 1894), to prevent the detonating composition working through the powder. The top is closed by the *safety plug*.

The *screw plug for needle disc* is tapped so as to screw into the body, and recessed. It is slightly coned at the bottom, and has a hole through the centre. Two holes are drilled in the top for the key in screwing the plug into the fuze. The *needle disc* is of copper, with the steel needle in the centre; it rests on the screw plug for needle disc.

The *screw collar* screws into the body over the screw plug, having two slots cut in its upper edges for that purpose.

The *needle* is of steel, and of the shape shown in the section, having four points. It is sprung into the needle disc, and the edge is soldered to the latter.

The *bottom plug* has a central hole, closed on the upper side by a disc of paper and one of shalloon, and two keyholes for screwing it in. It is secured and rendered damp-proof by cement and solder.

The thread of needle screw plug, edge of needle disc, and screw collar are now threaded with Pettman's cement, and the screw collar and needle disc surfaces are finally painted with the same material.

The fuze is prepared by simply removing the safety plug with the flat end of the "fuze key, universal"; an arrow on the plug shows the way it is to be turned.

Action.—The fuze is at rest in all its parts till direct impact takes place, or a graze at such an angle that the nose of the shell enters the object. When either of these events occurs, the needle is crushed down on to the detonating composition, which fires, and ignites the mealed powder in the conical holes and the fine-grain powder. The flash therefrom blows down into the shell and fires the charge.

The head of the needle being some distance below the head of the fuze, it cannot be touched or forced down on the detonating composition when any ordinary rammer is used for loading.

Mark IV differs from Mark III fuze in having a removable detonator, a single-pointed needle, and slightly smaller magazine containing 63 grains of powder.

Weight of fuze, 5 ozs. 7 drams.

Fuze, Percussion, Direct Action, Impact, No. 13.

Mark I.—This fuze is for use with lyddite shell for direct fire. It fits in the nose of the shell; the body is of gunmetal, 2·2 inches long, screwed outside to G.S. gauge, fitted with a steel cap, now of manganese-bronze, with safety pin; the cap is furnished with two T-shaped slots to fit over brass pins on the body of the fuze, and a key hole for fixing the fuze in the shell.

The fuze is made waterproof as much as possible by having a disc of foolscap paper cemented over the head, which is, with all openings made in the body, painted over with Pettman cement.

On the fuze passing through the R.L. it has been altered to agree as nearly as possible with Mark III, and then designated Mark I*, and so stamped.

It is prepared by simply removing the safety pin and cap before the shell is placed in the bore of B.L. ordnance.

Mark II was designed for R.M.L. high-angle fire lyddite shell.

Mark III. This Mark differs from the previous Marks in having additional arrangements in the head with a view to the exclusion of damp.

Marks I*, II and III fuzes are brought up to Mark IV pattern as nearly as possible, when passing through the R.L. for repair, and when so altered they are stamped thus—I**, II*, III*.

Mark IV is for future manufacture.

Weight of fuze, 10 oz.; weight of cap, 3 oz.

Fuze, Time and Percussion, Middle, No. 54.

(*Plate LVII.*)

Mark I has been altered to agree with Mark II, and is now Mark I*. In future conversion this Mark will be fitted with a solid wire safety pin, but in consequence of this no change in the designation will be necessary.

Mark II differs from Mark III in the percussion arrangement, the position of the detonator and needle being reversed.

The body of Mark III is hollow, with a stem on the upper side. Round the base of the stem an annular groove is cut, from which a hole is bored to the side of the body for the gas to escape. The sides of the body are pierced with three fire holes; the top of the body is screwed to receive an hexagonal cap. The cap fits the hexagonal hole in the centre of the "Key, fuze, universal." Between the cap and the dome fits a brass washer with feathers fitting into slots on the stem of the body; it is to prevent the dome from turning with the nut and altering the setting of the fuze when the cap is screwed tight.

The composition ring has an annular groove round it for the composition, a projection on the upper side contains the hammer with steel needle, suspended by a 0·022-inch wire, and a detonator under it for lighting the composition in the ring. The hammer is also secured by a safety pin passing under it, the hole in the ring left by its withdrawal being closed by a brass pellet with a spiral spring above it.

The composition ring is barrel shaped outside, to facilitate the setting of the fuze. The ring is kept in position by three projections on the side, which fit closely round the stem of the body. Two escape holes are at the top of the ring at the commencement of the composition, and three radial ones are bored through the inner side at equal distances round it.

The top and first radial hole are covered with paper, the two other radial holes with asbestos. The ring is graduated from 0 to 30, and reads quarter units. Each division has four subdivisions. There is an arrow head, or a black triangular mark, between the last graduation and the commencement, to show the position of safety.

The fuze is stamped T on the ring close to the "time" safety pin, and P on the body close to the "percussion" pin, to distinguish them, and the time pin is now fitted with a scarlet cord loop. If the

fuze is required to act as a percussion fuze only, the P pin should be withdrawn; if as a time fuze only, the T pin; and if as a time and percussion fuze, both pins.

To set the time arrangement of the fuze, the nut is loosened with the "Key, fuze, universal," and the ring moved round till the required graduation is opposite the arrow, or triangular mark on the body; the nut is then tightened, great care being taken to see that it is screwed down as tightly as possible.

The time of burning of the fuze at rest, when set at 30 or full length, is about 16 seconds.

Action.—The action of the time arrangement is that, on discharge, the hammer sets back, shearing the suspending wire, and fires the detonator, which lights the end of the ring of composition; this burns until the channel communicating with the lower part of the fuze is reached, when the flash passes down it and fires the detonator and magazine in the percussion arrangement.

Weight, 1 lb. 4 oz.

Note.—When the stock of this fuze is used up, "Fuze, T. and P., No. 62," will be used.

Fuze, Time, and Percussion, No. 62 (Mark I).

(*Plate LVIII.*)

The fuze principally consists of the following parts, which are made of gunmetal, except where otherwise stated:—Body, detonator plug with detonator, percussion pellet with needle plug and steel needle, brass safety pellet, brass ball, base plug, time composition rings (upper and lower), brass springs, dome, brass washer, cap, two safety pins, leather washer.

The *body* is screwed at the lower end to G.S. fuze-hole gauge, and bored from the bottom to receive the percussion pellet and base plug. Two holes are bored beyond the recess for the percussion pellet, one for the detonator plug, the other for the safety pellet. The hole bored for the detonator plug is continued horizontally to form a small magazine, which is filled with fine grain powder; the hole then leads upwards to join the time rings, and contains perforated pellet powder. The stem in the body is screwed to take the cap, two featherways being cut in top end of stem to receive corresponding feathers on the brass washer over dome. A small tablet of fine white paper is secured with shellac to the body of the fuze over the perforated powder pellet, and over this tablet are two washers, one of fine white paper, and the other of calfskin, which are secured with shellac, a hole being cut through the washers and tablet immediately over the powder pellet; similar tablet, pellet, and washers exist on top of the lower time ring.

The *detonator plug* is screwed on the outside to fit the hole prepared for it, and contains a detonator, which consists of a copper cap with fire holes filled with 3½ grains of detonating composition, with a ·005-inch brass disc under the composition and a tinfoil disc over it, to prevent the composition working through the holes.

The *percussion pellet* has a slot in the side for the safety pellet, and brass ball to fall into when set in action. For additional safety a hole is made transversely through the percussion pellet, and fitted with a brass retaining or centrifugal bolt, which engages in the body, and is held in position by a brass spiral spring; the outer end being the heavier

part of the bolt, it disengages itself from the body in flight. The percussion pellet contains 5½ grains of powder pellet perforated, having under the latter a muslin disc and brass washer, and over it one grain of fine grain powder, and then the needle plug, which is screwed in; the latter is perforated with six fire holes, and contains the steel needle. A small set screw in the body fits into a slot in the percussion pellet, to prevent the latter turning in flight. Two spiral springs prevent the percussion pellet creeping forward during flight and causing premature explosion; these springs have a seating in a shallow recess in top of the pellet, and the opposite end in a corresponding recess in the fuze body.

The *safety pellet* has a slot cut in the side to clear the brass ball, and is suspended in the body by a thin copper wire which passes through it. A hole is also bored in the body and upper part of pellet for the percussion safety pin; the hole in the body left by the removal of the safety pin is closed by a brass pellet having above it a spiral spring in compression.

The *base plug* contains pellet powder perforated; over the latter are two discs, one paper, the other muslin, and a brass washer, and under the pellet a shalloon disc and a brass washer. The base of the fuze is closed by the plug, which is made secure by being stabbed in in three places.

The *composition rings* have each a channel, which is lined with asbestos paper, for the fuze composition, and a hole is provided which allows the gas direct escape outside; this escape hole is lightly closed by means of a brass disc covered without by Pettman cement; there are three projections on the inside of the ring to keep it concentric with the body stem.

The upper ring has a chamber which contains a hammer with steel needle; the hammer is suspended by a ·022-inch copper wire, a safety pin also passes through the ring and under the hammer; the hole in the ring left by the withdrawal of the pin is closed by a pellet of brass as mentioned above for the percussion safety pin (*see* Safety Pellet). Under the needle is detonating composition and mealed powder. The composition channel on the under side and the chamber are connected by a lighting hole, the composition being roughened at the lighting point to assist ignition. The outside of the ring is barrel shaped, to facilitate setting, and is graduated from 0 to 30, each division being subdivided into halves and quarters, with an arrow point on bridge portion to mark the position of safety, *i.e.*, when the arrow and both pointers are in the same vertical plane.

The lower ring has a composition channel similar to the upper ring, the ring is flat on the outside and graduated in divisions as before mentioned for the upper ring, but reading from 30 to 60.

Two setting pointers are provided, one of which is fixed to the lower time ring by a screw, and the other to the body under the rings. The pointers are made of cupro-nickel, and blackened.

A pawl is fitted to the lower time ring of the fuze. When the lower part of the pawl is pressed into a slot in the body of the fuze, it prevents the lower time ring from turning while the upper ring is being set. When set at 30, or above, the upper end of the pawl fits into a slot in the upper time ring (in which position it is held by a spring) and locks both rings together.

The *dome, brass washer*, and *hexagonal* cap are put on the fuze in the order here given.

The dome is of sheet brass, stamped into shape, and covers the time lighting arrangement.

The washer has two feathers, which engage in featherways cut in the stem of fuze; its object is to prevent the dome from turning and altering the setting of the fuze through friction when screwing down the cap.

The cap must be clamped tightly; this is most important; if not done, the composition may explode instead of burning. Care must also be taken when clamping not to alter the setting.

The fuze is stamped T on the upper composition ring close to the time safety pin, and P on the body close to the percussion safety pin. These pins are each provided with a whipcord becket or loop, the T one being scarlet, and that of P tarred.

The openings in the fuze are coated with Pettman cement, to exclude damp.

A leather washer in a groove above the fuze hole thread makes a tight joint.

The fuze should be set *before* the safety pins are withdrawn.

To set the time arrangement, the cap is loosened with the "Key, fuze, universal," and the ring moved round until the graduation ordered and the pointer coincide; the fuze is then clamped by screwing down the cap as tightly as possible, care being taken that the ring and dome have even bearings, and the setting has not shifted.

If the fuze is required to act as a percussion fuze only, the P pin should be withdrawn and the T pin left in position; otherwise, both pins should be withdrawn, but this should not be done till the moment of loading.

Action.—On discharge, if the safety pin has been withdrawn, the hammer sets back, shearing the suspending wire, and igniting the detonator and the time ring, which burns until it comes over the pellet, and so flashes down through the radial magazine, percussion detonator pellet, and base plug, and into the shell.

If the percussion pin has been withdrawn, the safety pellet sets back, shearing the suspending wire, and the brass ball falls down into the space over the safety pellet. The centrifugal bolt, owing to the rotatien of the shell, is withdrawn, the percussion pellet is free to move forward on impact and ignite the detonator, which flashes through the percussion pellet and base plug into the shell.

The time of burning at rest is about 35 seconds.

Weight of fuze (about) 1 lb. 7 oz.

Drill Fuzes.

In present manufacture all drill fuzes are, to facilitate identification, stamped "Drill" and bronzed all over, with the exception of the time rings (and a patch showing the index), of drill, time, and percussion fuzes, which are left bright.

Fuze, drill, percussion, base, large, No. 11.—Service fuzes which have been burnt out, will, as far as possible, be utilized for this purpose, by being cleaned and refitted with empty screwed cap and plug.

Fuze, drill, percussion, D.A., with cap, No. 1.—This drill fuze is made of gunmetal, solid, and to the same external dimensions as the service fuze.

Fuze, percussion, D.A., impact, drill.—This drill fuze is generally similar in external appearance to the service fuze. It consists of a hollow body, removable cap, and steel split safety pin, which can be withdrawn and replaced as required. It is intended for use with the drill lyddite shell.

Fuze, drill, T. and P., middle, No. 54.—This drill fuze resembles the service pattern, but it is issued empty, and provided with special safety pins, which can be withdrawn and replaced as required. A steel washer is fitted under the cap.

TUBES.

(*Plates LIX to LXII.*)

Tubes, vent-sealing { electric, P.
electric, P., drill, * Mark III.
percussion.
percussion, drill, Mark I.

Primer, vent, cordite, Mark I,

The percussion lock arrangement necessitates a special tube for firing the charge, and this tube performs a double duty in sealing the vent when fired so as to prevent the escape of gas. The tubes, both for service and drill, are made of two patterns, for firing by hand or by electricity.

Tube, Vent-Sealing, Electric, P.

(*Plate LIX.*)

A full description of the latest pattern of this tube is given below, the other Marks differ in some manufacturing details only. Marks I to IV are to be used up for drill purposes.

Mark I was similar to II, but the wires were not tinned over, and the bridge was attached to the poles with ordinary solder.

Mark II was of solid drawn brass, in construction similar to III, but the wires were only 18 inches long.

Mark III: the cylindrical portion of the body was entirely filled with powder, the end being closed by a cork and paper disc, and the wires 1 inch shorter than in IV.

Mark IV: the wires are laid in two slots in the head, and passed through by separate holes, then through an asbestos plug and small air space, and soldered to two brass poles embedded in a conical ebonite plug, and the bottom end is closed with a sulphur pellet, in which is embedded a brass ball. *It must not be used unless the range is clear.*

Mark V is similar in construction to Mark VI, but it has the brass ball as in Mark IV, and the same precautions are necessary.

Mark VI is identical in construction to Mark VII, but the wires are led through a groove across the head instead of the V-shaped groove, and it is without the extra 5 inches of oiled silk wrapping on the wires.

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* When worn out, service tubes will be used instead.

Mark VII is made of brass bored out to receive the arrangement for firing by electricity. The interior of the body near the head is conical, a hole is drilled in the head through which pass two tinned copper wires twisted together and insulated by varnished silk; on the interior the wires are parted and led through a V-shaped groove across the head, they are then twisted together again and wrapped with oiled silk for a length of 5 inches, and terminate in spirals 22 inches from the tube; the spirals are covered with sarcenet. In the interior, near the head, are two cones, the larger one fitting into the recess of the body, the small one fitting into a conical recess in the large cone; they are insulated from each other and from the body by ebonite; the front end of one of the wires is attached to the rear end of the large cone, and the end of the other wire passes through the large cone; insulated from it and is attached to the rear end of the small cone. A copper pole is fastened to the front end of each of the cones, the cones being connected by a platinum-silver wire bridge, embedded in priming composition. The remainder of the tube is filled with pistol powder (in present manufacture pellet powder is used), the end is closed with a varnished cork and shellaced paper disc, and in latest manufacture the end of the tube is burred to secure the cork plug, and a paper disc is placed over the cork plug, to prevent it sticking to the cork bottom of the tube box.

Action.—The wires from the battery are connected to the wires of the tube, and on a current of electricity being passed through them, the bridge becomes incandescent and fires the tube. The cones are jammed into each other and the coned part of the body, and prevent any escape of gas through the head.

Packed 5 in a tin box.

Tube, Vent-Sealing, Percussion.*

(*Plates LX and LXI.*)

Mark II tube differs from Mark IV in not having the diagonal fire holes in the anvil.

Mark III is the same as Mark IV, except that the bottom of the tube is closed with a paper disc and perforated brass ball, embedded in sulphur and secured with shellac. *It must not be used unless the range is clear.* *See* Notes, page 116.

Mark IV.—This consists of a body, anvil, striker, brass washer, percussion cap, copper washer, two paper discs, and a cork plug. The body is made of brass, solid drawn; a hole is drilled through the head to receive the striker, which is secured in position by being riveted into the countersunk washer, as shown in the Plate. The upper part of the chamber is screwed and fitted with an anvil, on which is placed the percussion cap, the upper surface of which is in contact with the striker; a small central and two diagonal fire-holes are drilled through the anvil. The remainder of the space in the tube is filled with loose

* Percussion V.S. tubes of present manufacture are blacked, and have four notches cut in the rim of the head to distinguish them from wireless electric tubes by sight or touch. Previous issues of V.S. percussion tubes will be similarly dealt with on passing through the O.F. for any conversion. This will not necessitate any change in numeral.

pistol powder, and the bottom is closed with a paper disc and cork plug coated with varnish.

Action.—This is the same as Mark VI tube, excepting that the striker of the tube, together with the percussion cap, is driven on to the anvil, thus firing the tube.

Mark V tube differs from Mark VI in the form of the striker, which is without the cup-shaped gas-check and the detonator, which is held in position by a brass screwed collar. The tube is filled with R.L.G.[2] powder, the interstices being filled up with R.F.G.[2] powder, but in latest manufacture a special fine grain powder (those filled on or before 14th December, 1899, were filled with pistol powder); it is closed with a paper disc and cork plug coated with varnish. This mark will be used up for drill and instructional purposes only.

Mark VI tube consists of a body, striker, detonator, detonator holder, two washers, shearing wires, two paper discs, and cork plug.

The body is of solid drawn brass, the head is bored centrally for the striker, detonator and fire channel. The striker is of brass, with a needle point and a plain flange at its base, under which is fitted a copper cup-shaped gas-check, and it is held in position by a copper shearing wire passed through the tube and a brass washer in the recessed head of the tube. The detonator is fitted into the holder, and the latter is screwed into the body of the tube. Under the detonator holder is a copper washer and a disc of fine white paper. The lower part of the tube is filled with R.F.G.[2] powder siftings, or else a special fine grain powder (present manufacture). The tube is closed with a paper disc and cork plug, which is coated with varnish.

Action.—On firing the gun the point of the striker of the percussion lock drives the striker of the tube on to the detonator, thus firing the tube, the flash passing on to the charge.

Mark VII generally differs from Mark VI in having an anvil cast solid with the body, a copper percussion cap, a manganese-bronze striker with blunt point, and in latest manufacture the end of the tube is burred to secure the cork plug.

The head of the tube is bored out to receive the cap and a screw holder with the striker. There is a recess round the anvil for the reception of the cap, and three fire holes give passage to the flash. The cap is secured in position over the anvil by the screwed collar and holder, and contains the striker, the latter being kept clear of the cap by the usual copper shearing wire.

The action is similar to that mentioned for Mark IV.

Packed 10 in a tin box.

Tube, Vent-Sealing, Electric, P, Drill.*

(Plate LXII.)

Mark III is of gunmetal, in three parts, screwed together and milled outside. Two insulated copper wire terminals pass through a slot in the head, and are continued at right angles into the interior to form the poles, the holes bored for their reception in the head are lined with ebonite.

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* See footnote p. 113.

The slot in the head is covered with a small brass plate which affords the wires protection from friction against the percussion lock. The poles are connected by a platinum-silver bridge. Through the head are also two escape holes for the flash of the priming. The wires are whipped together near the head with black thread, and terminate in spirals 22 inches from the tube. The tube is issued empty. When required for use it will be charged with a small quantity of priming composition, the escape holes being lightly stopped with luting on the outside.

Mark II is similar to Mark III, but has the wire terminals only 18 inches long.

Mark I has wire terminating in brass spring sockets instead of spirals, and the wires in the groove in the head are not protected by the brass plate.

Tube, Vent-Sealing, Percussion, Drill.

(*Plate LXII.*)

This tube is made of gunmetal, the interior being bored out and the head fitted to receive the coned indiarubber plug as shown in the Plate. The lower part is closed by a gunmetal plug.

Primer, Vent, Cordite, Mark I.

This consists of a stick of cordite, size, 20, cut 4·75 inches long. It is for use wih powder charges and vent sealing tubes without ball, and is put in the vent after the breech is closed and before the tube is inserted.

Packed 10 in a box.

Lever, Extractor, Tube, *See* page 15.

Notes.

In the event of a tube failing to ignite a charge, care should be taken in extracting the fired tube not to stand directly in rear of the gun, as the gas generated will cause the primer to fly out with some violence when eased by the extractor.

The vent sometimes becomes choked with residue from the cartridge. It should be cleared with a pointed instrument sufficiently to allow the insertion of a tube, which, when fired, will remove the rest of the obstruction.

If a Mark IV or V electric, or Mark III, percussion, tube is used for this purpose, care should be taken that the range is clear, as the brass ball is projected with force to a considerable distance.

A tube is not to be inserted in the vent till the breech is properly closed.

Range Table for 10-inch B.L. Gun.

Based on Practice of 3 and 4.3.90 and 30.4.90.

40185
8649
..
9218
..
9552

Minutes 22,607, 23,027, 24,548, 41,975II.

Charges
- cordite
  - weight, 76 lb.
  - gravimetric density, $\frac{110 \cdot 1}{0 \cdot 252}$
  - nature, size 30
- powder
  - weight, 252 lb.
  - gravimetric density, $\frac{33 \cdot 23}{0 \cdot 844}$
  - nature, prism[1], brown.

Projectile
- nature, cast steel, common shell.
- weight, 500 lb.

Muzzle velocity, 2,040 f.s.

Nature of Mounting, barbette.

Jump, nil.

Remaining velocity.	To strike an object 10 feet high, range must be known within	Angle of descent.	5 minutes elevation or deflection alters point of impact.		Elevation.	Range.	Fuze scale for fuze, time and percussion middle, No. 54, Marks I*, II, or III.	50 per cent. of rounds should fall in.			Time of flight.	Penetration into wrought iron (into compound armour, it is $\frac{1}{10}$ of the penetration into W.I.).
			Range.	Laterally or vertically.				Length.	Breadth.	Height.		
f.s.	yards.	° ′	yards.	yards.	° ′	yards.		yards.	yards.	yards.	secs.	inches.
2022	1146	0 3	129	0·4	0 4	100	¼	20	0·05	0·1	0·14	22·4
2004	637	0 7	127	0·29	0 8	200	½	20	0·05	0·1	0 28	22·2
1987	432	0 11	125	0·43	0 12	300	1¼	20	0·1	0·1	0·43	22·0
1970	332	0 15	124	0·58	0 16	400	1⅝	20	0·1	0·1	0·58	21·9
1954	260	0 19	122	0·72	0 20	500	2	20	0·1	0·1	0·84	21·7
1938	220	0 23	121	0·87	0 25	600	2½	20	0·15	0·1	0·89	21·5
1922	189	0 27	119	1·01	0 29	700	2¾	20	0·15	0·1	1·04	21·3
1906	168	0 32	118	1·16	0 33	800	3¼	20	0·2	0·1	1·20	21·1
1891	149	0 36	116	1·31	0 37	900	3½	19	0·2	0·2	1·36	20·9
1876	133	0 41	115	1·45	0 41	1000	4	19	0·25	0·2	1·54	20·7
1861	120	0 46	113	1·60	0 45	1100	4¼	19	0·25	0·2	1·68	20·5
1847	107	0 51	112	1·74	0 50	1200	4¾	19	0·3	0·3	1·85	20·3
1832	96	0 56	111	1·89	0 54	1300	5¼	19	0·3	0·3	2·02	20·1
1818	88	1 1	110	2·03	0 59	1400	5½	19	0·35	0·3	2·19	20·0
1804	82	1 6	109	2·18	1 3	1500	6	19	0·35	0·3	2·36	19·8
1790	77	1 11	108	2·32	1 8	1600	6¼	19	0·4	0·4	2·52	19·6
1776	72	1 16	106	2·47	1 12	1700	6¾	19	0·4	0·4	2·70	19·5
1762	68	1 22	104	2·61	1 17	1800	7¼	19	0·45	0·4	2·86	19·3
1748	65	1 27	102	2·76	1 22	1900	7½	19	0·5	0·5	3·03	19·1
1734	62	1 33	100	2·91	1 27	2000	8¼	19	0·55	0·5	3·20	18·9
1720	58	1 39	98	3·05	1 31	2100	8½	19	0·55	0·5	3·37	18·8
1706	55	1 45	96	3·21	1 36	2200	9	19	0·55	0·6	3·54	18·6
1691	52	1 51	95	3·34	1 40	2300	9½	19	0·6	0·6	3·72	18·4
1677	48	1 58	93	3·49	1 45	2400	10	19	0·65	0·6	3·91	18·3
1663	45	2 5	92	3·63	1 49	2500	10½	19	0·65	0·7	4·07	18·1
1649	44	2 13	91	3·78	1 54	2600	11	19	0·7	0 7	4·24	18·0
1635	42	2 20	90	3·92	1 59	2700	11½	19	0·75	0·7	4·43	17·8
1621	40	2 28	89	4·07	2 4	2800	12	19	0·8	0·8	4·60	17·6
1607	38	2 36	87	4·21	2 9	2900	12½	19	0·8	0·8	4·79	17·5
1593	36	2 44	86	4·36	2 15	3000	13	19	0·85	0·8	5·00	17·3

Remaining velocity.	To strike an object 10 feet high, range must be known within	Angle of descent.	5 minutes elevation or deflection alters point of impact.		Elevation.	Range.	Fuze scale for fuze, time and percussion middle, No. 5A, Marks I*, II, or III.	50 per cent. of rounds should fall in.			Time of flight.	Penetration into wrought iron (into compound armour it is $\frac{4}{5}$ of the penetration into W.I.).
			Range.	Laterally or vertically.				Length.	Breadth.	Height.		
f.s.	yards.	° ′	yards.	yards.	° ′	yards.		yards.	yards.	yards.	secs.	inches.
1579	35	2 52	84	4·51	2 20	3100	13½	19	0·9	0·9	5·18	17·2
1565	34	3 0	83	4·65	2 26	3200	14	19	0·95	0·9	5·36	17·0
1551	32	3 8	82	4·80	2 31	3300	14½	19	0·95	1·0	5·56	16·9
1537	30	3 17	81	4·94	2 37	3400	15	19	1·0	1·0	5·76	16·8
1523	28	3 25	80	5·09	2 42	3500	15½	19	1·0	1·1	5·96	16·6
1510	26	3 34	79	5·23	2 48	3600	16	19	1·1	1·2	6·16	16·4
1496	25	3 43	78	5·38	2 54	3700	16½	19	1·1	1·2	6·36	16·2
1483	24	3 53	77	5·52	3 0	3800	17	20	1·2	1·3	6·56	16·1
1469	24	4 3	76	5·67	3 6	3900	17½	20	1·2	1·4	6·77	15·9
1456	22	4 12	75	5·81	3 12	4000	18½	20	1·3	1·5	6·98	15·8
1443	22	4 22	74	5·96	3 18	4100	19	20	1·3	1·6	7·20	15·6
1430	20	4 32	73	6·11	3 24	4200	19½	21	1·4	1·7	7·43	15·5
1417	20	4 42	72	6·25	3 30	4300	20	21	1·4	1·8	7·66	15·3
1404	18	5 53	72	6·40	3 36	4400	20½	21	1·5	1·9	7·90	15·2
1391	18	5 3	71	6·54	3 42	4500	21	22	1·6	2·0	8·14	15·0
1378	18	5 14	71	6·69	3 49	4600	22	22	1·6	2·1	8·38	14·8
1365	17	5 26	69	6·83	3 56	4700	22½	23	1·7	2·2	8·62	14·7
1352	17	5 36	67	6·98	4 3	4800	23	23	1·8	2·3	8·86	14·5
1339	17	5 47	65	7·13	4 10	4900	24	23	1·8	2·4	9·10	14·4
1326	15	5 59	64	7·27	4 18	5000	24½	24	1·9	2·6	9·34	14·3
1313	15	6 11	62	7·42	4 25	5100	25	25	1·9	2·7	9·58	14·1
1301	15	6 23	62	7·56	4 33	5200	25½	25	2 0	2·9	9·83	14·0
1289	15	6 35	61	7·71	4 40	5300	26	26	2·1	3·0	10·08	13·9
1277	13	6 47	61	7·85	4 48	5400	27	26	2·1	3·2	10·33	13·8
1265	13	6 59	60	8 00	4 55	5500	27½	26	2·2	3·3	10·56	13·6
1253	13	7 12	60	8·14	5 3	5600	28	27	2·3	3·5	10·82	13·5
1241	13	7 25	59	8·29	5 11	5700	29	27	2·3	3·6	11·06	13·4
1229	13	7 38	59	8·43	5 19	5809	30	28	2·4	3·8	11·30	13·3
1218	13	7 51	58	8·58	5 27	5900	...	28	2·5	3·9	11·53	13·2
1207	12	8 4	58	8·73	5 35	6000	...	28	2·6	4·1	11·77	13·0
1196	12	8 17	57	8·87	5 43	6100	...	29	2·7	4 3	12·01	12·9
1186	12	8 31	57	9·01	5 51	6200	...	29	2·8	4·5	12·25	12·8
1176	12	8 44	57	9·16	5 59	6300	...	29	2·9	4·7	12·40	12·6
1166	12	8 58	56	9·30	6 8	6400	...	29	3·0	4·9	12·65	12·5
1156	10	9 11	56	9·45	6 16	6500	...	30	3·1	5·2	13·0	12·4
1147	10	9 25	56	9·60	6 25	6600	...	30	3·1	5·4	13·24	12·3
1138	10	9 38	55	9·74	6 33	6700	...	31	3·2	5·7	13·48	12·1
1129	10	9 52	55	8·89	6 42	6800	...	31	3·3	6·0	13·72	12·0
1121	10	10 6	55	10·03	6 51	6900	...	32	3·3	6·3	13·97	11·9
1114	8	10 20	55	10·18	7 0	7000	...	33	3·4	6·6	14·22	11·8
1106	8	10 34	54	10·32	7 8	7100	...	33	3·5	6·9	14·47	11·7
1098	8	10 48	54	10·46	7 17	7200	...	34	3·5	7·2	14·72	11·6
1090	8	11 2	54	10·60	7 25	7300	...	35	3·6	7·5	14·97	11·5
1082	8	11 17	54	10·75	7 34	7400	...	36	3·6	7·9	15·22	11·4
1077	6	11 32	53	10·89	7 43	7500	...	37	3·7	8·3	15·48	11·3
1071	6	11 47	53	11·04	7 52	7600	...	37	3·8	8·6	15·74	11·2
1064	6	12 2	53	11·19	8 0	7700	...	38	3·8	9·0	16·00	11·2
1058	6	12 18	53	11·34	8 9	7800	...	39	3·9	9·4	16·28	11·1
1053	6	12 34	52	11·48	8 18	7900	...	40	3·9	9·8	16·46	11·1
1048	6	12 50	52	11·63	8 27	8000	...	41	4·0	10·2	16·83	11·0
1043	6	13 6	52	11·77	8 36	8100	...	41	4·1	10·6	17·10	11·0
1038	6	13 22	52	11·92	8 46	8200	...	42	4·1	11·0	17·40	10·9
1033	6	13 38	52	12·07	8 55	8300	...	42	4·2	11·4	17·67	10·9
1028	6	13 55	51	12·22	9 4	8400	...	44	4·2	11·9	17·96	10·8
1023	6	14 11	51	12·36	9 13	8500	...	45	4·3	12·3	18·24	10·8
1019	6	14 28	51	12·50	9 23	8600	...	45	4·4	12·8	18·52	10·7
1015	6	14 45	51	12·65	9 32	8700	...	46	4·5	13·3	18·82	10·7
1011	6	15 2	51	12·80	9 42	8800	...	47	4·5	13·8	19·10	10·6
1007	6	15 19	51	12·94	9 51	8900	...	48	4·6	14·3	19·40	10·6
1003	6	15 36	50	13·08	10 1	9000	...	49	4·7	14·9	19·70	10·5

Remaining velocity.	To strike an object 10 feet high, range must be known within.	Angle of descent.	5 minutes elevation or deflection alters point of impact.		Elevation.	Range.	Fuse scale for fuze, time and percussion middle No. 54, Marks I*, II, or III.	50 per cent. of rounds should fall in.			Time of flight.	Penetration into wrought iron (into compound armour it is ⅘ of the penetration into W.I.).
			Range.	Laterally or vertically.				Length.	Breadth.	Height.		
f.s.	yards.	° ′	yards.	yards.	° ′	yards.		yards.	yards.	yards.	secs.	inches.
1000	6	15 53	50	13·23	10 11	9100	...	49	4·7	15·4	20·00	10·5
996	5	16 10	50	13·37	10 21	9200	...	50	4·8	16·0	20·30	10·4
992	5	16 27	50	13·52	10 31	9300	...	51	4·9	16·6	20·62	10·4
988	5	16 45	50	13·66	10 41	9400	...	52	5·0	17·3	20·93	10·3
984	5	17 3	50	13·81	10 51	9500	...	53	5·1	18·0	21·25	10·2
980	5	17 21	50	13·96	11 1	9600	...	53	5·1	18·7	21·56	10·2
977	5	17 39	50	14·11	11 11	9700	...	54	5·2	19·4	21·87	10·1
974	5	17 58	50	14·26	11 21	9800	...	55	5·3	20·1	22·19	10·1
971	5	18 17	50	14·40	11 31	9900	...	56	5·4	20·9	22·52	10·0
968	5	18 36	50	14·55	11 41	10000	...	57	5·5	21·6	22·84	10·0
963	5	18 55	40	14·69	11 54	10100	...	57	5·5	22·3	23·20	...
959	5	19 14	40	14·83	12 6	10200	...	58	5·6	23·0	23·54	...
956	5	19 33	40	14·96	12 18	10300	...	59	5·7	23·7	23·88	...
953	5	19 52	40	15·12	12 31	10400	...	60	5·8	24·4	24·22	...
950	5	20 11	40	15·27	12 44	10500	...	61	5·9	25·1	24·55	...
946	5	20 31	39	15·42	12 57	10600	...	61	5·9	25·8	24·89	...
943	5	20 50	39	15·56	13 10	10700	...	62	6·0	26·5	25·23	...
939	5	21 10	38	15·71	13 23	10800	...	63	6·1	27·2	25·57	...
936	5	21 30	38	15·85	13 37	10900	...	64	6·2	27·9	25·91	...
933	5	21 50	37	16·00	13 51	11000	...	65	6·3	28·6	26·26	...
929	4	22 10	37	16·14	14 4	11100	...	65	6·3	29·3	26·61	...
926	4	22 30	37	16·29	14 7	11200	...	66	6·4	30·0	26·96	...
922	4	22 50	36	16·44	14 31	11300	...	67	6·5	30·7	27·31	...
919	4	23 11	36	16·57	14 45	11400	...	68	6·6	31·4	27·66	...
916	4	23 31	36	16·73	14 59	11500	...	69	6·7	32·1	28·02	...

19*th August*, 1899.
11*th July*, 1900.
1*st* „ 1902.

Range Table for 10-inch B.L. Gun, Marks I to IV.

(Half Charge.)

Based on Practice and Calculation.

Minutes 20,561, 20,933.

57
16
3260

Charge { weight, 38 lb. | gravimetric density, $\frac{220 \cdot 2}{0 \cdot 126}$ | nature, Cordite, size 30.

Muzzle velocity, 1,393 f.s.

Nature of mounting, barbette.

Jump, nil.

Projectile, weight 500 lb.

Remaining velocity. (Actual.)	5 minutes elevation or deflection alters point of impact.		To strike an object 10 feet high, range must be known within	Angle of descent.	Elevation.	Range.	Time of flight.
	Range.	Vertically or laterally.					
f.s.	yards.	yards.	yards.	° ′	° ′	yards.	secs.
1382	55	·14	521	11	10	100	·22
1370	55	·29	283	20	19	200	·45
1358	54	·43	199	29	28	300	·67
1346	54	·58	147	39	37	400	·90
1344	53	·72	117	49	46	500	1·12
1322	53	·87	93	59	55	600	1·35
1311	52	1·01	82	1 9	1 4	700	1·57
1300	52	1·16	71	1 19	1 13	800	1·80
1289	51	1·31	64	1 29	1 22	900	2·03
1278	51	1·45	59	1 40	1 32	1000	2·26
1268	50	1·60	51	1 51	1 41	1100	2·50
1258	50	1·74	46	2 2	1 51	1200	2·74
1247	49	1·89	43	2 13	2 0	1300	2·98
1237	49	2·03	40	2 24	2 10	1400	3·22
1226	48	2 18	37	2 35	2 20	1500	3·46
1216	48	2·32	34	2 46	2 30	1600	3·70
1206	48	2·47	32	2 57	2 40	1700	3·95
1197	47	2·61	30	3 9	2 50	1800	4·20
1189	47	2·76	28	3 21	3 0	1900	4·45
1181	47	2·91	27	3 33	3 10	2000	4·70
1174	46	3·05	25	3 46	3 21	2100	4·95
1167	46	3·20	24	4 0	3 32	2200	5·20
1160	45	3·34	23	4 13	3 43	2300	5·46
1153	45	3·49	21	4 27	3 54	2400	5·62
1146	44	3·63	20	4 41	4 6	2500	5·78
1139	44	3·78	19	4 55	4 18	2600	6·25
1132	43	3·92	18	5 9	4 30	2700	6·57
1125	43	4·07	18	5 24	4 42	2800	6·77
1118	42	4·21	17	5 39	4 54	2900	7·03
1111	42	4·36	16	5 55	5 7	3000	7·30
1104	42	4·51	15	6 11	5 19	3100	7·52
1097	41	4·65	14	6 27	5 32	3200	7·85
1090	41	4·80	14	6 43	5 44	3300	8·18
1083	41	4·94	14	7 0	5 57	3400	8·42
1076	40	5·09	13	7 16	6 9	3500	8·71
1069	40	5·23	13	7 33	6 22	3600	9·00
1062	39	5·38	12	7 50	6 34	3700	9·28
1055	39	5·52	12	8 8	6 47	3800	9·57
1044	38	5·67	11	8 25	6 59	3900	9·86
1042	38	5·81	11	8 42	7 12	4000	10·18

5th April, 1903.

DRILL FOR 10-INCH B.L. ON DISAPPEARING AND BARBETTE MOUNTINGS.

The gun detachment consists of a Gun Captain, a Gun Layer, and eleven other gun numbers.

It falls in and is told off in the usual manner.

For the duties of Gun Captain and Gun Layer, see Garrison Artillery Training.

Ammunition Supply.

Cartridges are supplied from depôts (or recesses where they exist) by hand to the gun.

Projectiles are supplied from recesses in the emplacement, and from depôts, which should be arranged round the gun platform under cover of the parapet.

When lifts from the shell and cartridge stores exist, they may be used for direct supply in action if necessary.

The normal supply of ammunition will be from recesses or depôts; in this case **6, 8, 10** and **12** supply cartridges, and **7, 9** and **11** supply projectiles, this supply must be made intelligently, as the gun is traversed, from the most convenient recess or depôt.

When supply is from the lift, the lids of cylinders will be loosened at the foot of the lift. Empties will be stacked by **6** and **8** without obstructing the working of the gun.

As the depôts and recesses only hold a limited number of rounds, it will be advisable not to reduce the total for each gun below eight, but when this point has been reached, to change to lift supply.

In addition to the above detail, when guns are served by lift direct, six to nine additional numbers will be required to supply and work the lift.*

10-INCH B.L. ON DISAPPEARING MOUNTINGS.

To Prepare for Action.

Gun Group Commander.	Gun Captain.
"*A Group, prepare for action.*"	"*A* 1, *prepare for action.*"

At this order stores are brought up as follows:—

Gun Captain.—A piece of chalk, key of raising valve, gauges pressure and necessary spanners.

Gun Layer.—Sights, pointer for traversing arc, locks electric and percussion, battery and key test and firing, lanyard and screw driver.

2.—Pocket gun layers, vent bit, rimer, tube box and tubes, wrenches breech and firing mechanism, McMahon spanner, oil can, Russian tallow and waste, medium scotch. For drill a drill tube.

3.—Loading tray or trays, handle of control gear, traversing handles.

---

* If only one lift is provided, three of these numbers should be detailed to carry cartridges in cylinders to cartridge recess or depôts direct, the lift being reserved for shell only.

4.—Combined sponge and rammer, scraper with brush, bucket filled with water, and sponge cloth.

5.—Elevating wheels, if not already on the mounting, loading tackle, handle of lowering pump and assists Gun Layer.

6 and **8.**—Keys of cartridge and shell recess and of lifts (if necessary) and for drill, drill cartridges in zinc cylinders and cartridge extractor.

7 and **9.**—Projectile barrow and brush, 2 selvagees, 2 keys fuze universal, 2 keys base fuze and plug when required and grease box. For drill, a drill shell and shell extractor.

10.—Assists **4.**

11.—Assists **7** and **9.**

12.—Assists **3.**

The following group stores will be brought up, and such other stores as are considered necessary, locally :—

Hammers, claw	1 per group.
Clinometer	1 per 3 guns or less per work.
Wrench nut vent	1 per work.
Lever extractor	1 per work.
Whistle	1 per group or less per work.
Reservoir compressed air ..	1 per mounting.

The Gun Captain will satisfy himself that the liquid level and air pressure are correct. He sees that the cap squares are properly secured.

When the breech is opened he looks to see that the bore is clear. When firing by P.F. he sees that the firing plug is ready for use, and places his stores in a convenient position for use.

The Gun Layer places the lanyard under his waist belt, fixes the sights in the gun and shield, taking care that the fore-sights fit correctly and that the deflection leaves of the hind-sights work easily ; he attaches the battery to the mounting (if not already on) and makes the necessary connections, examines the lock and places it in position in the breech screw, and tests the firing circuit by firing a tube after the breech is closed, he sees that the pointer for traversing arc is let down. When P.F. is used and permanent leads are not fitted, he coils up the electric cable and places it in the safety firing plug recess.

2 straps the Layer's pocket and tube box round his waist or to a convenient part of the mounting, and places some tubes in the box, the remainder of his tubes and stores in a convenient position for use.

3 removes breech and muzzle covers and places them on the right of his position under cover, puts on handle of control gear, and places loading tray or trays in a convenient position for use, and disconnects the holding down clip or bolt on his own side.

The detachment remove covering plates if on.

2 and **3** open the breech as follows :—

2 raises the cam lever into its upright position, **3** raises the ratchet lever to the full extent (sees that the ratchet catches), and with both hands forces it down until the cam lever is hard against the stop. **3** turns handle of control gear with his left hand, thus withdrawing and opening the breech. When the breech is open, **2** passes the vent bit down the vent, examines the breech screw and threads of the breech, seeing that they are clean and free from burrs, lubricates the threads with a slight film of oil and smears the obturating pad with Russian tallow. When the Gun Captain has looked through the bore, they close

the breech in the reverse manner.* As soon as the breech is locked, 2 inserts a tube and lowers the cam lever, he then disconnects holding-down clip or bolt on his own side. With electric firing the spiral wires of the tube should be attached while the breech is being locked.

4 places the bucket in rear of the gun and the side arms heads to the front, combined sponge and rammer resting on the bucket, scraper with brush along side of it on the ground, and sees that the elevating gear is oiled and in working order.

5, after assisting the Layer, places the elevating wheels on (if not already there) and the handle of the lowering pump in position on the mounting, hooks the loading tackle (if not already fixed) overhauls, and secures it.

6, 8, 10 and 12 unlock cartridge and shell recesses or lifts, go to the cartridge recess or lift, loosen or remove bands from covers of cylinders (if not already done). At drill place the drill cartridges and cylinders outside the cartridge recess.

7, 9 and 11 go to the shell recess, depôt or lift, and prepare shell for loading, *i.e.*, clean and fuze them (if not already done). For drill, place the drill shell in a convenient position for use.

7 hands fuze key to 2.

If the nature of projectile is known, a shell will be placed on the loading tray (Mark I mounting), as detailed below.

Each number will report to the Gun Captain regarding any damage or deficiency.

After each number has completed his work he takes post as follows:—

Gun Captain in the most convenient position.

Gun Layer at the manhole, on the sighting step, or in the most convenient position according to mounting.

2 on the right of the gun, facing the breech.

3 on the left of the gun, facing the breech.

4 at the head of the side arms.

5 at the loading tackle.

6, 7, 8, 9, 10, 11 and 12 as above detailed.

The Gun Captain will then report his gun "*Bore Clear, Ready to Load.*"

To Load.

Gun Group Commander.	Gun Captain.
"*A Group .....Load.*"	"*A 1 .....Load.*"

3 assisted by 2 opens the breech as before detailed.

3.—With Mark II mountings, places the loading tray in the breech; when the loading tray is in two parts, 2 supplies the front portion, 3 the rear portion.

7, 9 and 11.—Bring up the projectile on the barrow, to the left of the breech,† 5 attends to the tackle, 7 hooks the lower block to the selvagee.

---

* After closing the breech screw by means of the control gear, 3 will give a back turn of the handle of about 8 inches to bring the breech screw in the proper position for locking with ratchet lever, the amount of back turn to be increased or diminished as found necessary to prevent undue strain being put on the ratchet gear.

† With Mark II mountings the barrow is run over the tray on the curved rack, the projectile is placed in it and raised by 7, 9 and 11 to the level of the gun, and then rammed home.

7, 9, 11 and **12** man the fall and hoist the shell, **5** steadying it.

5 swings it in and, assisted by **2** and **3**, pushes it on to the loading tray; when over the loading tray, **3** holds up his hand as a signal to ease off; the numbers on the fall ease off. **3** casts loose the selvagee and, assisted by **5**, swings the loading tray round; **2** removes the safety pin and uncaps the fuze; **4** supplies the combined rammer and sponge and places it against the projectile which is rammed home by :—

2, 4, 6 on the right,

3, 5, 7 on the left.

The shell is rammed home in one motion, **2** and **3** being near the breech, the other numbers at the end of the stave; **4** and **5** withdraw the rammer and **4** keeps it in rear of the breech in case it is required for the cartridges; **5** overhauls the loading tackle.

With powder, **6, 8, 10** and **12** bring up the cartridge cylinders, with the lids unscrewed to the last thread, and place them in a convenient position, taking care that they are clear of the shell numbers; **6** and **8** on the right, **10** and **12** on the left, hand the cartridges to **2** and **3** who will place them in the breech, **3** removing the shalloon patch from the base of the last cartridge.

In the case of cordite, **6** and **8**, or **10** and **12**, alternately will supply the bare cartridges, with millboard discs removed, to **2** and **3**.

2 and **3** push home the cartridges, using the rammer if necessary, when **4** assists.

3 withdraws the loading tray and lays it down.

4 now removes the sponge cloth from the mushroom head, wiping off any loose residue from the previous round, and puts it back in the bucket.

3 closes the breech, and **2** inserts a tube in the vent, as before detailed, and lowers the cam lever till caught by the spring catch.

4 and **5** then man the elevating wheels.

6, 8 and **12** remove empty cylinders and place another charge in a convenient position for loading.

7 and **9** bring up another projectile in the barrow. The projectile will be raised on to the loading tray during any convenient pause.

The shell numbers will change rounds when required at the discretion of Gun Captain.

2, 3, 10 and **11** man the traversing wheels.

10 and **11** will not go into the well, but will stand on the circular platform.

To Run Up.

See Garrison Artillery Training.

5 attends to the lever of the raising valve.

To Lay and Fire.

See General Instructions, Garrison Artillery Training.

The normal method of firing is by electricity. If percussion firing is used, the layer hooks the lanyard as soon as the gun has risen above the top of the shield or parapet. The normal means of laying is by shield sights, and on other occasions by straight-edged sights.

(For drill after firing, &c., see pp. 131, 132.)

10-INCH B.L. ON BARBETTE MOUNTINGS, MARKS I, II, III.

To Prepare for Action.

Gun Group Commander.	Gun Captain.
"*A Group, prepare for action.*"	"*A* 1, *prepare for action.*"

At this order stores are brought up as follows :—

Gun Captain.—A piece of chalk.

Gun Layer.—Sights, pointer for traversing arc, firing battery (if not already on the mounting), electric and percussion locks, lanyard and screw driver.

2.—Pocket gun layers, vent bit and rimer, tube box and tubes, wrenches, breech and firing mechanism, McMahon spanner, oil can, Russian tallow and waste, medium scotch. For drill, a drill tube.

3.—Traversing handles, handle control gear, loading tray or trays.

4.—Combined sponge and rammer, scraper with brush, bucket filled with water, and sponge cloth.

5.—Elevating wheels (if not already on the mounting), winch handle, 2 rammer ropes (if required), and assists Gun Layer.

6, 8.—Keys of cartridge and shell recesses (if necessary) and of lifts. For drill, drill cartridges in zinc cylinders and cartridge extractor.

7 and 9.—Projectile barrow and brush, 2 selvagees, 2 keys fuze universal, 2 keys base fuze and plug when required and grease box. For drill, a drill shell and shell extractor.

10.—Handle of floating pivot pump (when required), and assists **4.**

11.—Assists **7** and **9.**

12.—Assists **3.**

The following group stores will be brought up and such others as are considered necessary locally :—

Hammers, claw	1 per group.
Clinometer	1 per 3 guns or less per work.
Wrench nut vent	1 per work.
Lever extractor	1 per work.
Whistles	1 per group.

The Gun Captain will satisfy himself that the buffers are properly connected up, not leaking at the glands, and contain the correct amount of oil. When the breech is opened he looks to see that the bore is clear.

The Gun Layer places the lanyard under his waist belt, fixes the sights in the gun, taking care that the foresights fit correctly and that the deflection leaves of the hindsights work easily. He sees that the pointer for traversing arc is let down. He attaches the battery to the mounting (if not already on), makes the necessary connections. He examines the lock and places it in position in the breech screw, and tests the firing circuit by firing a tube after the breech is closed. When P.F. is used and permanent leads are not fitted, he coils up the electric cable and places it in the safety firing plug recess.

2 straps the Layer's pocket and tube box round his waist or to a convenient part of the mounting and places some tubes in the box, the remainder of his tubes and stores in a convenient position for use.

3 removes breech and muzzle covers and places them on the right of his position under cover, puts on the traversing handles and handle of control gear, and places loading tray or trays in a convenient position for use.

2 and 3 open the breech as follows :—

2 raises the cam lever, 3 raises the ratchet to its full extent, sees that the ratchet catches, and with both hands forces it down till the cam lever is hard against the stop; 3 turns handle of the control gear with his left hand, thus withdrawing and opening the breech.

When the breech is open, 2 passes the vent bit down the vent, examines the breech screw and threads of the breech, seeing that they are clear and free from burrs, lubricates the threads with a slight film of oil, and smears the obturating pad with Russian tallow. When the Gun Captain has looked through the bore, they close the breech in the reverse manner.* As soon as the breech is locked, 2 inserts a tube and lowers the cam lever. With electric firing the spiral tube wires should be attached while the breech is being locked.

4 places the rammer, scraper and brush, and the bucket filled with water in a convenient position in rear of the gun, or on counterweight, 4 sees that the elevating gear is oiled and in good working order.

5, after assisting the Layer, places the elevating wheels on (if not already there), and, assisted by 4, elevates the gun to the loading position, places on the winch handle, and coils down the rammer ropes clear of the working of the gun.

6 and 8, 10 and 12, go to the cartridge recess or lift, loosen or remove bands from covers of cylinders, if not already done. For drill they place drill cartridges and extractor in a convenient position for use.

7, 9 and 11 go to the shell recess, depôt, or lift (if supply is by lift), and prepare shell for loading, *i.e.*, clean and fuze them if not already done. For drill they place the drill shell and extractor in a convenient position for use.

7 hands fuze key to 2.

Each number will report to the Gun Captain regarding any damage or deficiency.

After each number has completed his work, he takes post as follows:—

Gun Captain in the most convenient position.
Gun Layer on the sighting platform.
2 on the right of the gun, facing the breech.
3 on the left of the gun facing the breech.
4 at the head of the side arms.
5 at the loading tackle.
6, 7, 8, 9, 10, 11 and 12 as above detailed.
The Gun Captain reports his gun "Ready to Load."

To Load.

Gun Group Commander.	Gun Captain.
"*A Group.....Load.*"	"*A 1.....Load.*"

2, 3, 4 and 5 mount on loading stage.

3, assisted by 2, opens the breech as before detailed.

3 places the loading tray in the breech; when the loading tray is in two parts, 2 supplies the front portion, 3 the rear portion.

* See footnote, p. 123.

7, 9 and 11 bring up the projectile on the barrow to the left rear of the breech, **7** having previously fuzed the shell. **5** attends to the derrick, **7** hooks the derrick tackle to the selvagee; **7** and **9** man the winch handle and hoist the shell, **5** and **11** steadying it. **5** swings it in towards the breech of the gun by the derrick lever, and **3** steadies the projectile, and when over the loading tray holds up his hand as a signal to ease off, which is done by **5** by means of the brake. As soon as the projectile is lowered on to the tray, **3** casts loose the selvagee, **2** removes the safety pin and uncaps the fuze, **5** swings the derrick clear, **4*** supplies the combined sponge and rammer, and places it against the projectile; it is then manned by **2** and **4** on the right and **3** and **5** on the left. The shell is rammed home in one motion, **2** and **3** being near the breech, the other numbers at the end of the stave. As soon as the shell is home, **4** and **5** withdraw the rammer and **4** keeps it in rear of the breech in case it is required for the cartridges.

With powder, **6, 8, 10** and **12** bring up the cartridge cylinders, with lids unscrewed to the last thread, and place them in a convenient position, taking care that they are clear of the shell numbers; **6** and **8** on the right side, **10** and **12** on the left, hand the cartridges to **2** and **3**, who will place them in the breech, **3** removing the shalloon patch from the end of the last cartridge.

In the case of cordite, **6** and **8**, or **10** and **12** alternately, will supply the bare cartridges, with millboard discs removed, to **2** and **3**.

2 and **3** push home the cartridges, using the rammer if necessary, when **4** assists.

3 withdraws the loading tray and lays it down.

4 now removes the sponge cloth from the mushroom head, wiping off any loose residue from the previous round, and puts it back in the bucket.

3 closes the breech.

2 inserts a tube in the vent as before detailed, and lowers the cam lever till caught by the spring catch.

When all are clear of recoil, **2** gives the word "*A* 1 *Ready.*" At percussion firing **2** will not give the word "*Ready*" until the Gun Layer has hooked the lanyard and is clear of recoil.

4 and **5** then bring the gun to the proper elevation for range under the orders of the Gun Captain.

6, 8 and **12** remove empty cylinders and place another charge in a convenient position for loading.

7 and **9** bring up another projectile in the barrow.

The shell numbers will change rounds when required at the discretion of the Gun Captain.

2, 3, 10 and **11** man the traversing handles, **10** first raising the slide into the traversing or raised position, by working the handle of the floating pivot pump.

To Lay and Fire.

See General Instructions, Garrison Artillery Training.

The normal method of firing is by electricity.

---

* If the combined rammer and sponge and bucket cannot be arranged on the mounting, **10** supplies combined rammer and sponge to **4** with the sponge cloth on the head.

If percussion firing is used, the Layer hooks the lanyard as soon as the gun is loaded and in the firing position.

As soon as the gun has been fired, **4** and **5** elevate into the loading position without further word of comand.

(For drill after firing, &c., see pp. 131, 132.)

10-INCH B.L. ON BARBETTE MOUNTINGS, MARK IV.

To Prepare for Action.

Gun Group Commander.	Gun Captain.
"....*Prepare for action.*"	"....*Prepare for action.*"

At this order stores are brought up as follows :—

Gun Captain.—A piece of chalk, key of firing plug box, pressure gauge No. 1, and necessary spanners.

Gun Layer.—Sights, pointer for traversing arc, firing battery (if not already on mounting), locks electric and percussion, screw driver.

2.—Pocket gun layers, vent bit, rimer, tube box, tubes, wrenches, breech and firing mechanism, McMahon spanner, oil can, Russian tallow, waste, spanner buffers, and medium scotch. For drill, a drill tube.

3.—Handle of control gear, percussion lanyard.

4.—Combined sponge and rammer, scraper with brush, bucket filled the water, and sponge cloth.

5.—Loading tackle. Assists Gun Layer.

6 and **8.**—Keys of cartridge and shell recesses and of lifts (if necessary), and for drill cartridges in zinc cylinders and cartridge extractor.

7 and **9.**—Projectile barrow and brush, 2 selvagees, 2 keys fuze universal, 2 keys base fuze and plug when required, grease box, a supply of bolts eye lifting. For drill, a drill shell and extractor.

10.—Elevating wheel, and assists **4.**

11.—Traversing wheel, and assists **7** and **9.**

12.—Assists **6** and **8.**

The following group stores will be brought up and such other stores as are considered necessary locally :—

Hammer, claw..	1 per group.
Clinometer	1 per 3 guns or less per work.
Lever Extractor	1 per work.
Whistle	1 per group.
Wrench nut vent	1 per work.

The Gun Captain will satisfy himself that the buffer is properly connected up, not leaking at the glands, and contains the correct amount of oil and air pressure, and that the accumulator is filled with liquid, and that the capsquares are properly secured.

When the breech is opened, he looks to see that the bore is clear, places his stores in a convenient position for use.

The Gun Layer fixes the sights on the cradle, and sees that they work and fit properly, and that the sight carrier is firmly attached to the mounting ; when automatic sights are used, he tests them, he attaches the electric firing battery to the mounting, if not already on, and makes the necessary connections ; he examines the lock and places it in position in the breech screw, and tests the firing circuit by firing a

tube after the breech is closed, sees that the elevating gear is oiled and in working order.

2 straps the layer's pocket and tube box round his waist or to a convenient part of the mounting, and places some tubes in the box, the remainder of his tubes and stores in a convenient position for use.

3 removes breech and muzzle covers, places them on the right of his position under cover, and puts on the handle of control gear.

2 and 3 open the breech as follows :—

2 raises the cam lever, 3 raises the ratchet to its full extent, sees that the ratchet catches, and with both hands forces it down till the cam lever is hard against the stop, 3 turns handle of the control gear with his left hand, thus withdrawing and opening the breech.

When the breech is open, 2 passes the vent bit down the vent, examines the breech screw and threads of the breech, seeing that they are clear and free from burrs, lubricates the threads with a slight film of oil, and smears the obturating pad with Russian tallow.

When the Gun Captain has looked through the bore, they close the breech in the reverse manner.*

As soon as the breech is locked, 2 inserts a tube and lowers the cam lever. With electric firing the tube wires should be attached while the breech is being locked.

4 places the sponge and rammer, scraper, brush, and the bucket filled with water in rear of the gun, sponge head resting on the edge of bucket.

5, after assisting the Gun Layer, hooks the loading tackle (if not already fixed), overhauls and secures it.

6, 8, 10 and 12 go to the cartridge recess or lift, loosen or remove bands from covers of cylinders (if not already done). For drill they place drill cartridges and extractor in a convenient position for use.

7, 9 and 11 go to the shell recess depôt, or lift (if supply is by lift) and prepare shell for loading, *i.e.*, clean and fuze them, if not already done. For drill they place the drill shell and extractor in a convenient position for use.

7 hands fuze key to 3.

As soon as they find out the nature of projectile to be used, they proceed to fill the six shell trolleys; 7 attending to the control lever of hoist, 9 to the trolleys.†

9 and 11 pass filled trolley as required over the rear hoist, 11 then fixes traversing wheel, and takes post to traverse.

10, after assisting 4, fixes elevating wheel, and then takes post to elevate.

After each number has completed his work he takes post as follows :—

Gun Captain in the most convenient position.

Gun Layer on the sighting step in rear of the sight.

2 on the right of the gun, facing the breech.

3 on the left of the gun, facing the breech.

4 at the head of the sidearms

5 on the right of 3.

6, 8 and 12 on landing of staircase, outside cartridge recess, or at head of lift.

---

* See footnote, p. 123.

† 9 must be careful to see that the hinged bearing straps are not on the swing as the hoist rises, otherwise they will be struck up by the projectile which will thus be tilted and fall out of the tray.

7 and **9** at front hoist or at depôt, recess, or lift.
10 at elevating wheel on emplacement floor.
11 at traversing wheel on emplacement floor.
The Gun Captain reports his gun "Ready to Load."

To Load.

Gun Group Commander.	Gun Captain.
"....*Group*.....*Load*"	"*A* 1.....*Load*"

2 and **3** open the breech, **2** attends to lever of rear shell hoist.
3 swings loading tray round in rear of breech.
11 runs round trolley with shell over rear hoist, taking care that the clip on shell pit shield rests on recess in trolley.
The Gun Captain now gives **2** the signal to raise the shell; as soon as the shell is level with the loading tray he gives the word "*Halt*," **2** halts by bringing lever to centre.
2 must be careful not to raise the shell too fast, or the hoist tray will come violently against the loading tray and damage the ram and hoist; **3** removes safety pin and uncaps the fuze when necessary.
4 then supplies himself with the combined sponge and rammer, places the head against the base of the shell; it is then manned by **3**, **5**, and Gun Captain on the left, **2**, **4** and **8** on the right.
The shell is rammed home in one motion, **2** and **3** being near the breech, the other numbers at the end of the stave; **4** and **5** withdraw the rammer and **4** keeps it in rear of the breech in case it is required for the cartridges.
When the shell is home, **2** lowers the shell hoist, leaving lever at "Lower."
11 removes the empty trolley and takes post to traverse.
With powder, **6**, **8**, **10** and **12** bring up the cartridge cylinders, with lids unscrewed to the last thread, and place them on staging in rear of mounting, taking care that they are clear of the shell numbers; **6** and **8** on the right side, **10** and **12** on the left, hand the cartridges to **3** and **5**, who will place them in the breech, **3** removing the shalloon patch from the base of the last cartridge.
In the case of cordite, **10** and **12** on the emplacement floor supply the bare cartridges, with millboard discs removed, to **6** and **8** on the gun floor, who supply them to **3** and **5**.
3 and **5** push home the cartridges, using rammer if necessary, when **4** assists.
3 withdraws the loading tray and swings it clear.
4 now removes the sponge cloth from the mushroom head, wiping off any loose residue from the previous round, and puts it back in the bucket.
3 closes the breech.
2 inserts a tube in the vent as before detailed, and lowers the cam lever till caught by the spring catch.
When all are clear of recoil, **2** gives the word "*A* 1 *Ready*." At percussion firing **2** will not give the word "*Ready*" until **3** has hooked the lanyard and is clear of recoil.
6, **8** and **12** remove empty cylinders and place another charge on staging.
7 and **9** keep the trolleys filled.
The shell numbers will change rounds when required at the discretion of the Gun Captain.

To Load by Derrick.

This method is only used when the hydraulic lifts are not working.

7 and **9** run projectile underneath derrick hatch, **5** passes lower block to **7**, who hooks it into eyebolt or bight of selvagee. **7**, **9**, **11** and **12** man running end of fall, **5** and **10** steadying the projectile.

When up, **3** and **5** steady and guide the projectile into loading tray, **3** unhooks the tackle, **5** unscrews the eyebolt or removes selvagee and overhauls the tackle.

3 and **5** swing loading tray into loading position.

Loading then proceeds as for hydraulic loading.

To Lay and Fire.

See General Instructions, Garrison Artillery Training.

The normal method is by electricity. If percussion firing is used, **3** hooks the lanyard as soon as the breech is locked.

The normal means of laying is by rocking bar sight at long ranges and by automatic sight when the target is within effective auto-sight range.

When firing is by Case II or III, **10** will be responsible that the elevation is put on correctly, and that the firing plug is inserted as ordered by the Gun Captain.

When firing is by P.F. Case III, the Gun Layer will put on the training himself, by means of the gear below.

At percussion firing, **3** fires as laid down in Garrison Artillery Training.

AFTER FIRING, ALL MOUNTINGS.

As soon as the gun is fired, the Gun Captain removes the firing plug if used; the Gun Layer (with disappearing and Mark IV mountings **3**) unhooks the lanyard (with barbette mountings the gun is brought to the loading position by the elevating numbers); **2** and **3** open the breech; **4** lays the sponge cloth over the mushroom head—he will not wring it out, but place it on as wet as possible; **2** extracts the old tube and rimes out the vent.

If using brown powder, as soon as the combined sponge and rammer is withdrawn, the Gun Captain will inspect the chamber, and, if necessary, order the scraper with brush to be used; **4** will supply himself with scraper and brush, and brush out any residue, being careful to see that none remains in the threads of the breech screw. This should seldom be necessary, if the sponge and sponge cloth are kept wet and are properly used.

TO RUN BACK.

Disappearing Mountings.

On the signal or order "*Run Back*" from the Gun Captain, **5** ships the handle of the lowering pump and, assisted by **2**, **3** and **4**, runs back. If the gun does not fall at each stroke of the pump, tackles must be used to assist; on no account are jacks to be used to force the gun down. As soon as the gun is down, the Gun Captain gives the word or signal "Halt;" **5** unships the handle of the lowering pump and replaces it.

Old Pattern Barbette Mountings.

If necessary, guns on these mountings can be run back as follows :—

A special derrick is attached to the bracket of the carriage on the right side, and by a hoisting tackle attached to it the pump is hoisted high enough to allow a projection on the bottom of it to rest in a recess in the bracket of carriage. It is now clamped in this position by two clamps attached to bracket. The connecting pipe is attached to delivery on pump and the filling hole in rear of the right buffer. By attaching and working pump handle* the gun can be run back the required amount.†

Note.—The pump is also used in this manner for filling the buffers, or they may also be filled in the ordinary manner, but, owing to the small aperture at the filling hole, it takes a considerable time.

Mark IV Mounting.

The pump running back portable will be used, see page 81.

TO UNLOAD AT DRILL, ALL MOUNTINGS.

2 and **3** open the breech, **3** places loading tray, **2** and **3** withdraw cartridges alternately (if necessary) using the cartridge extractor, which will be supplied by **6**, and place them in the cylinders; **2** places medium scotch on the loading tray as a fulcrum, in order to raise base of shell on to loading tray.

7 supplies the shell extractor and selvagee to **3**. The gun is then unloaded by the same numbers that loaded it, **3** sees that the loading tray is in the proper position to protect the threads of the breech screw.

For "Action," "Under Cover," "Miss-Fire," "Cease Firing," "Replacement of Casualties," "Detachment Rear," see Garrison Artillery Training.

The positions under cover are as follows :—

2, **4** and Gun Captain on the right, **2** nearest the gun.

3, **5** and Gun Layer on the left, **3** nearest the gun.

6, **8**, **10** and **12** at cartridge recess or depôt.

7, **9**, and **11** at the shell recess or depôt.

TO CEASE FIRING, AND REPLACE STORES.

The stores are replaced by the numbers who brought them up.

With H.P. mountings **2** and **3** secure the elevator by the holding down clips or bolts. The Gun Captain will see that the holding down clips are connected, that the gun does not rest on the stops, and that the lever of the raising valve is secured by chain and padlock.

The detachment then falls in "Detachment Rear."

---

* Nos. **4** and **10** bring up and attach pump handle, which is manned by **4**, **7**, **8** and **10**.

† When running back, the bye-pass valve of the pump must be kept closed, and opened to run up again, the Gun Layer attending to the valve.

ALTERATIONS.

Para. of List of Changes.	Nature of Change.	Remarks.

Para. of List of Changes.	Nature of Change.	Remarks.

Para. of List of Changes.	Nature of Change.	Remarks.

Para. of List of Changes.	Nature of Change.	Remarks.

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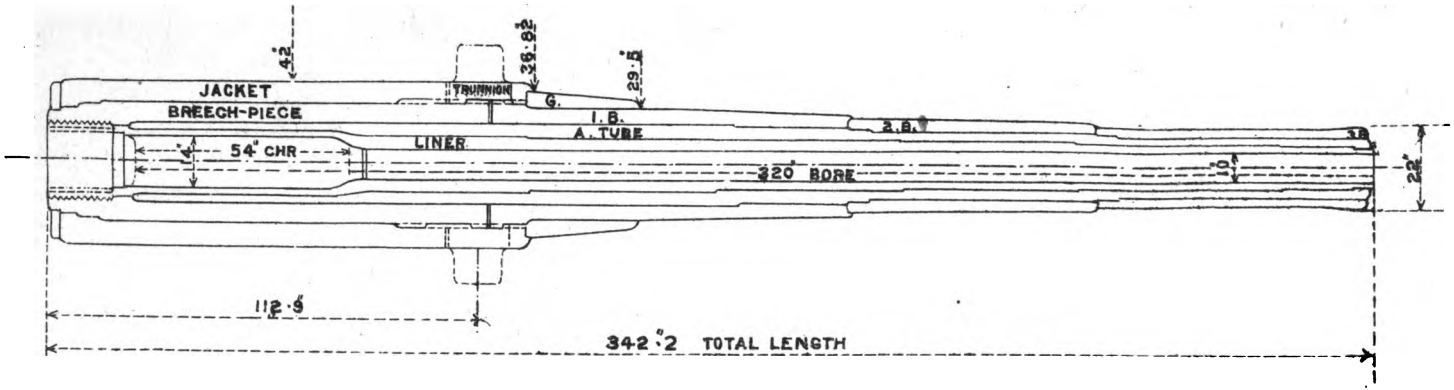
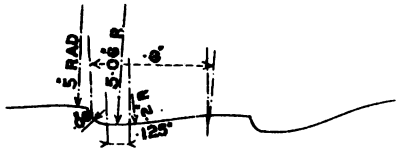
ORDNANCE, B. L., 10-INCH, MARK I.

SCALE $\frac{1}{50}$.



GROOVE FULL SIZE.



RIFLING AN INCREASING TWIST FROM 1 TURN IN 60 CALS AT BREECH TO 1 IN 30 AT MUZZLE.
Nº OF GROOVES 40.

Plate 1.

ORDNANCE, B.L., 10-INCH MARK II, STEEL, 28 TON.

SCALE 1/40.

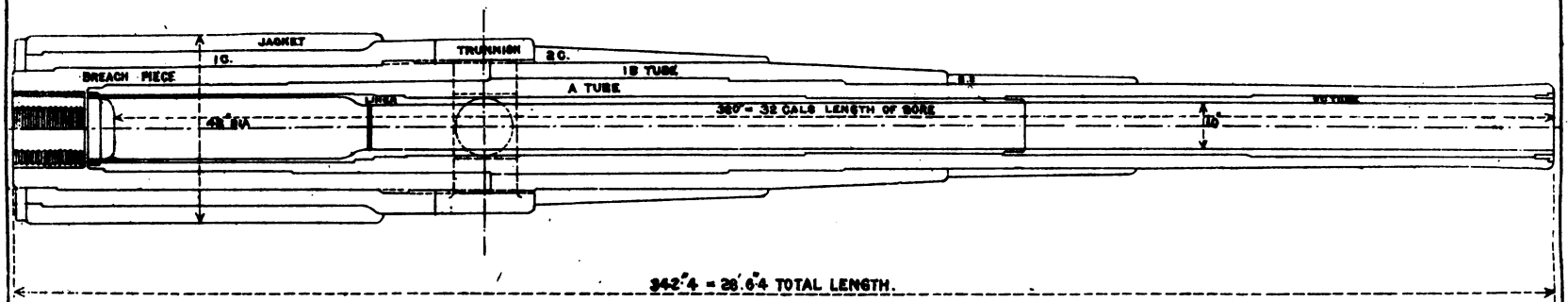
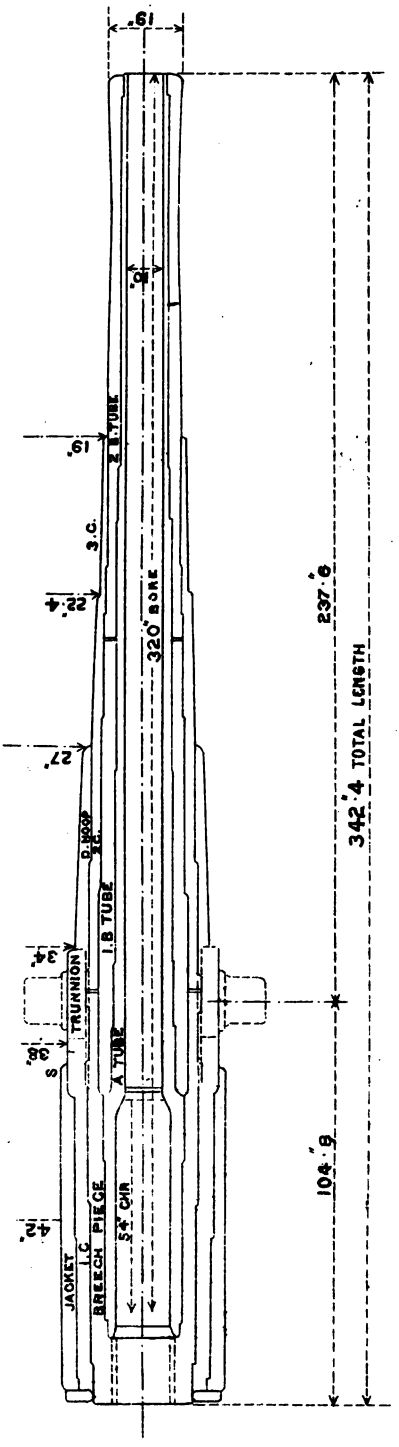
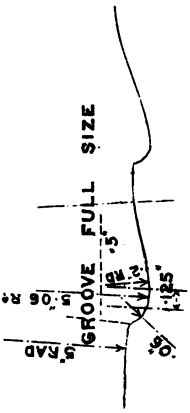


Plate II

Ordnance, B. L., 10-Inch, Mark III.

Scale 1/30.





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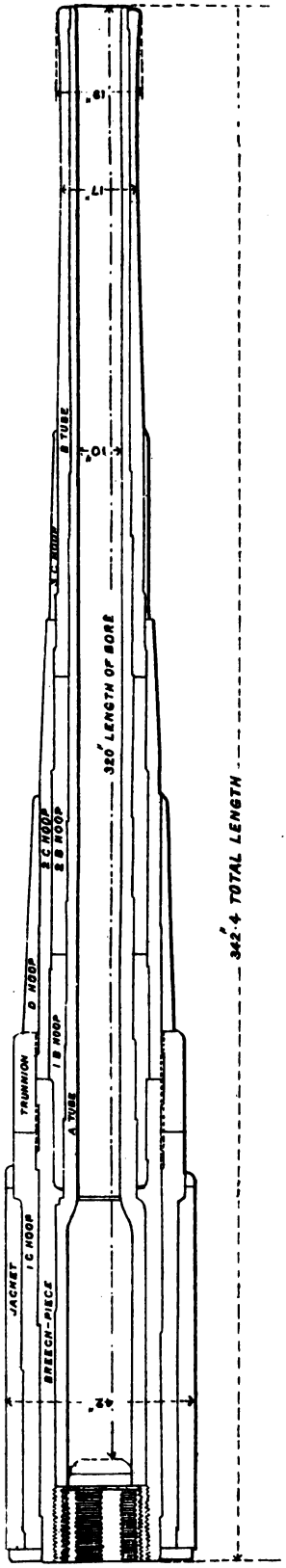
ORDNANCE, B.L., 10 INCH, MARK III^A.

STEEL 29 TON.

SCALE 1/40.



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ORDNANCE, B. L., 10 INCH, MARK IV

29 TON.

SCALE 1/40.

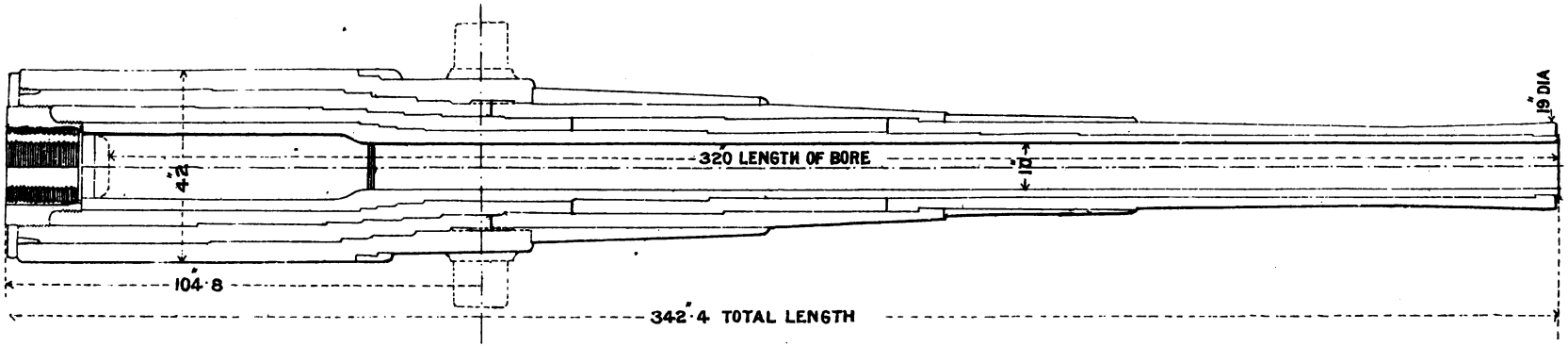


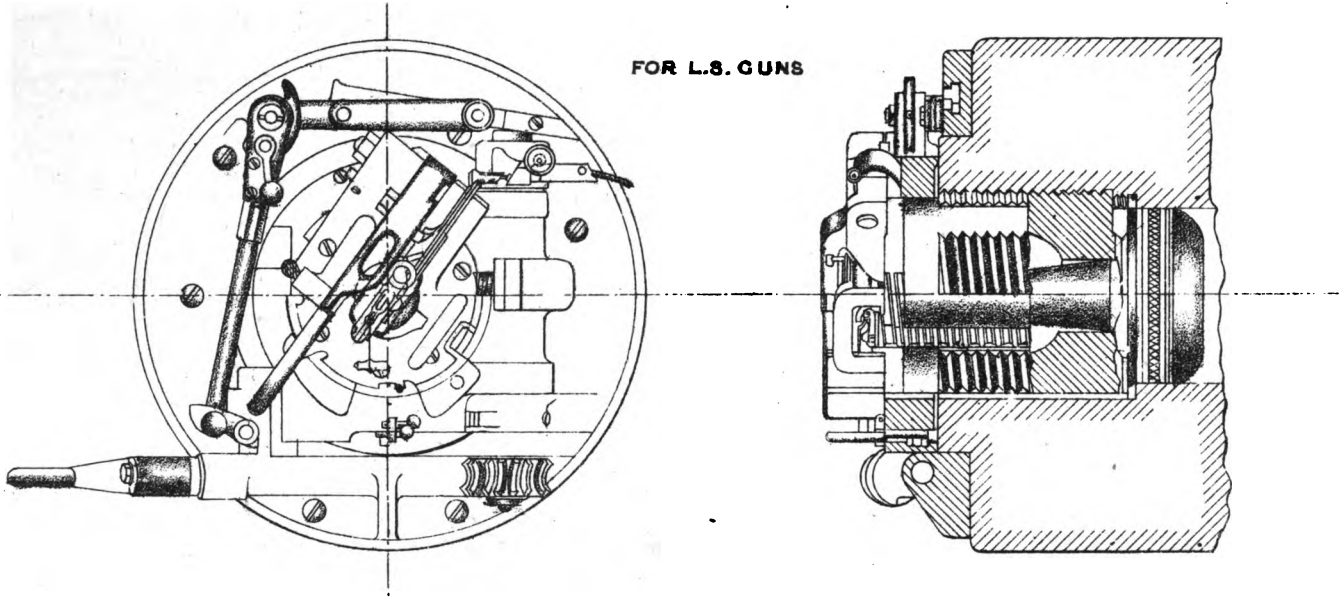
Plate V

ORDNANCE, B. L. 10 INCH, MARKS I, II, III. IV.

BREECH CLOSING ARRANGEMENT.

SCALE ¼.

FOR L.S. GUNS



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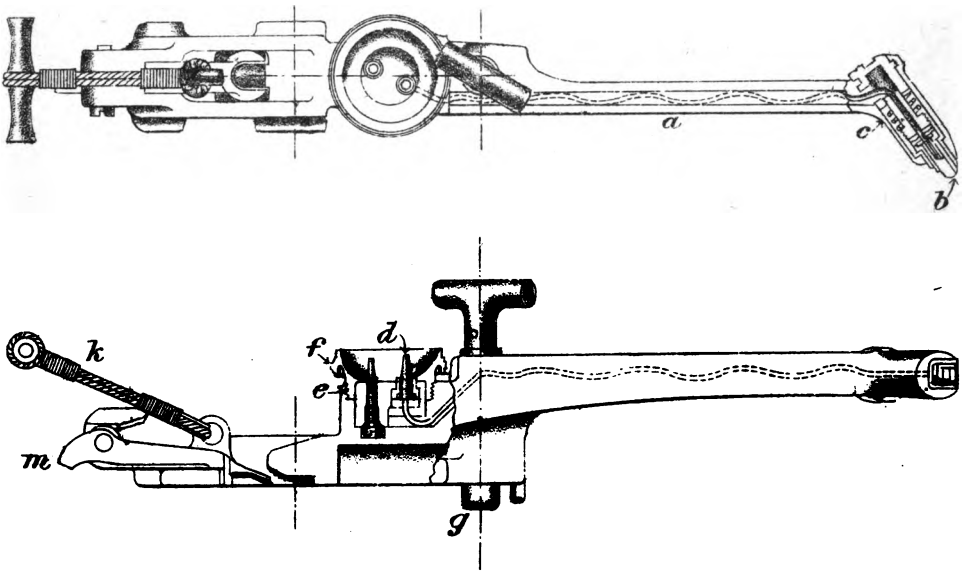
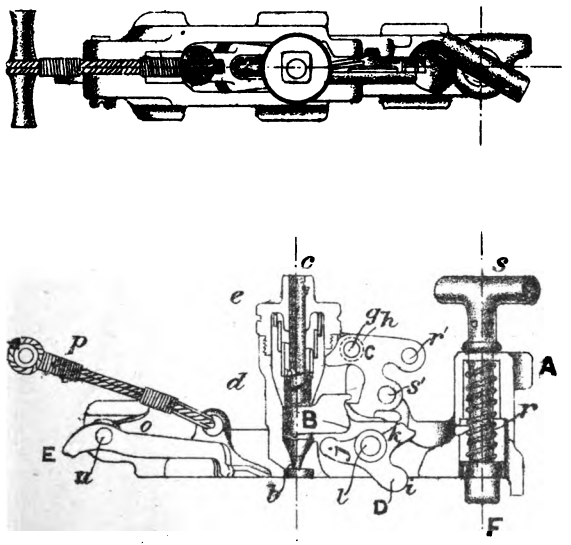
ORDNANCE, B.L., LOCK, ELECTRIC, "B".



ORDNANCE, B.L., LOCK PERCUSSION, "D".



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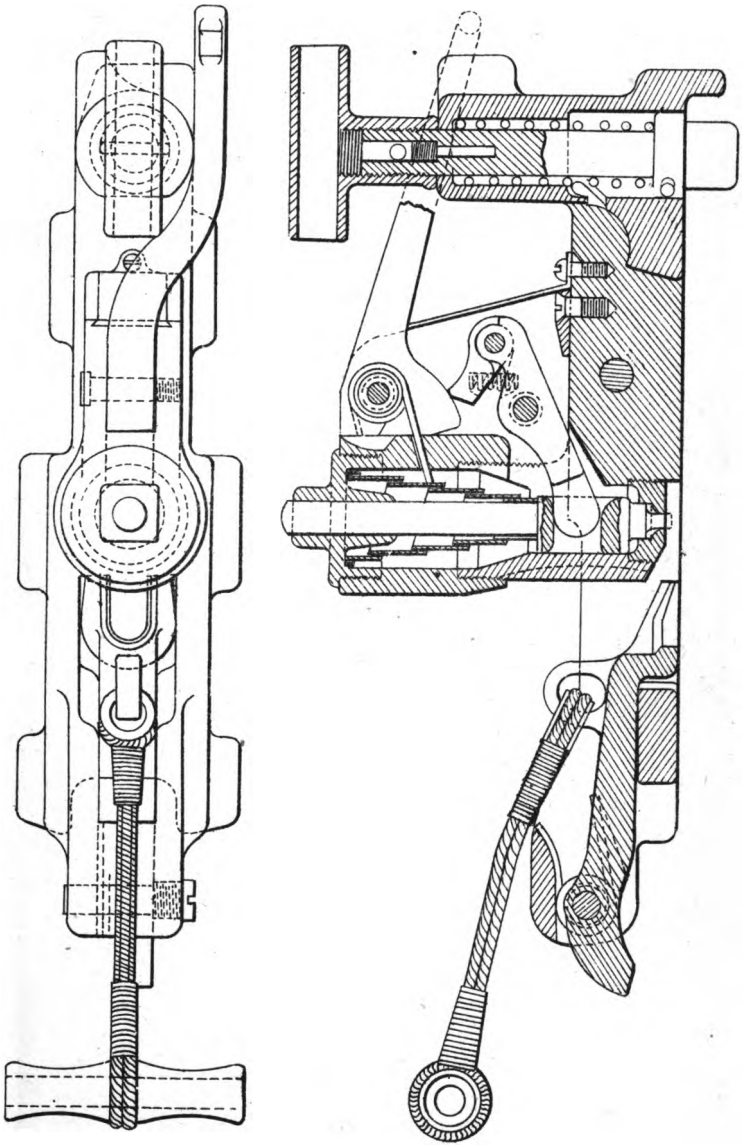
ORDNANCE, B.L, LOCK. PERCUSSION J. (MARK I)

SCALE ½.



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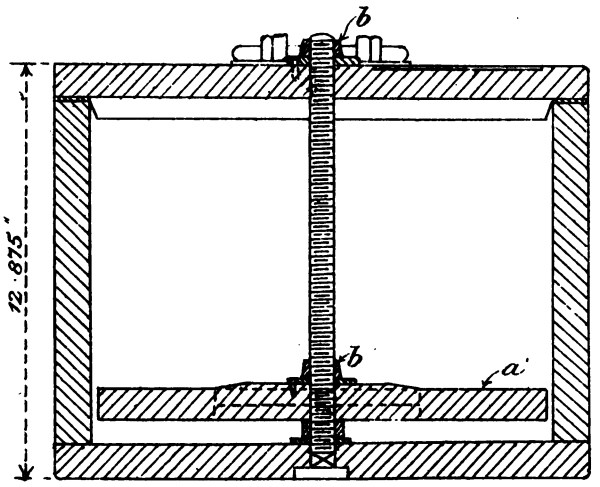
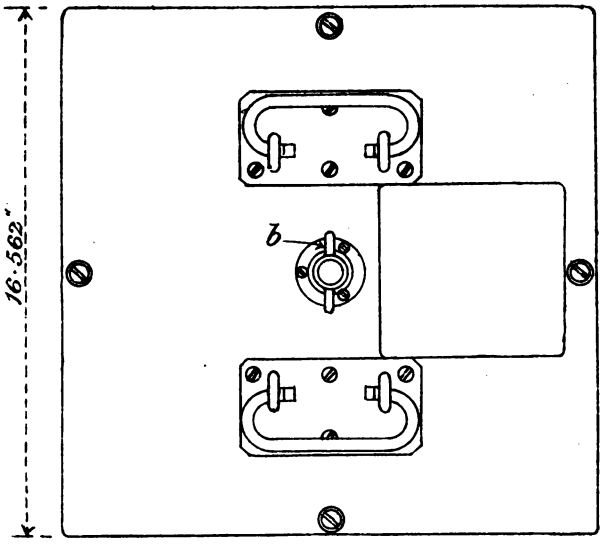
BOX, OBTURATING PADS AND DISCS, B.L. 10 IN: (Mk II) C

1/3 SCALE.



SECTIONAL ELEVATION.



PLAN.

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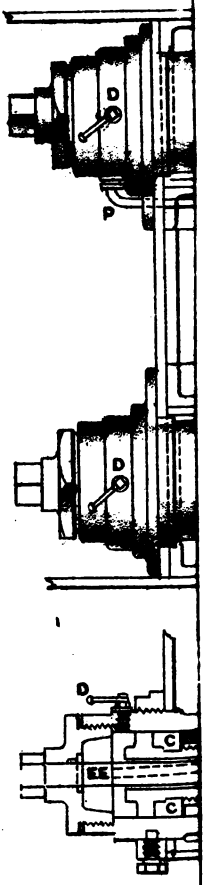
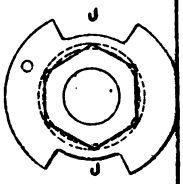
MOUNTING MARK I



END VIEW OF PIST



SECTION OF ELEVATING GEAR

Scale $\frac{1}{8}$

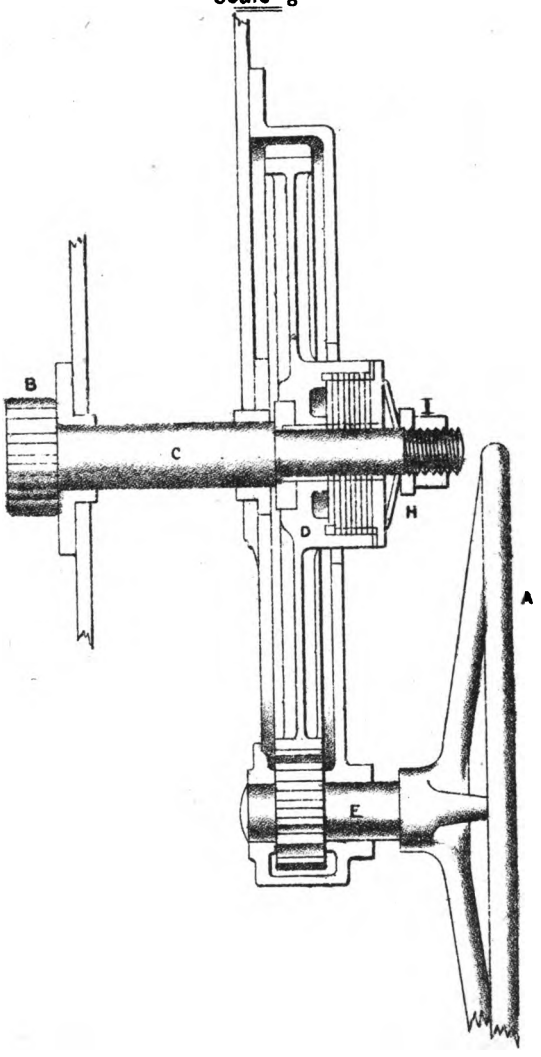


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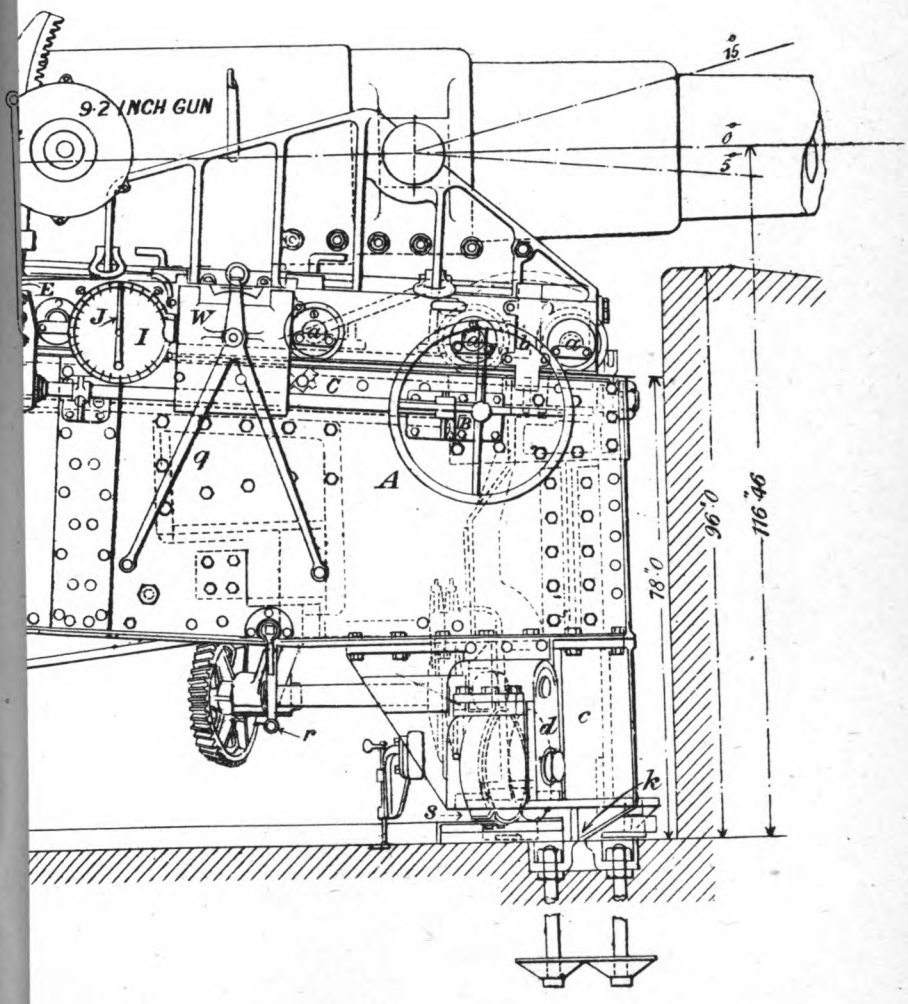
Plate XIV.

B.L., 9·2 INCH, MARK II.

H.

NCH, MARK II.

1.



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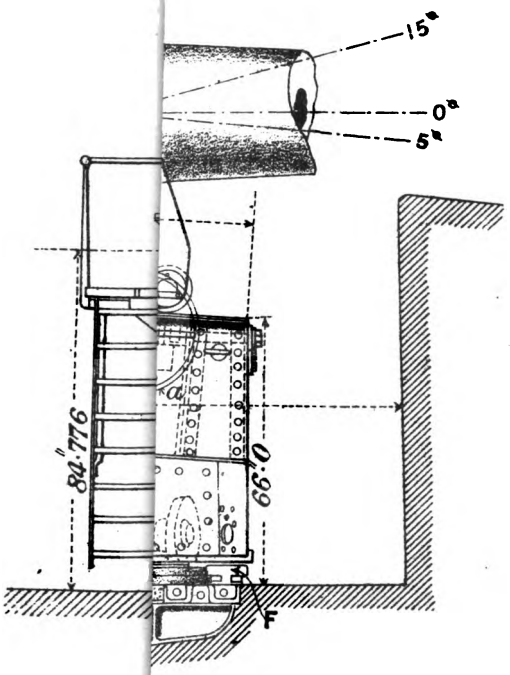
7 FEET

Plate XVI.

CAK III.



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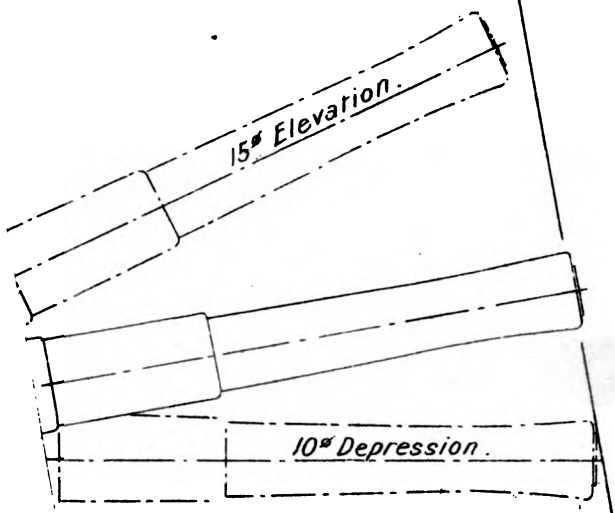
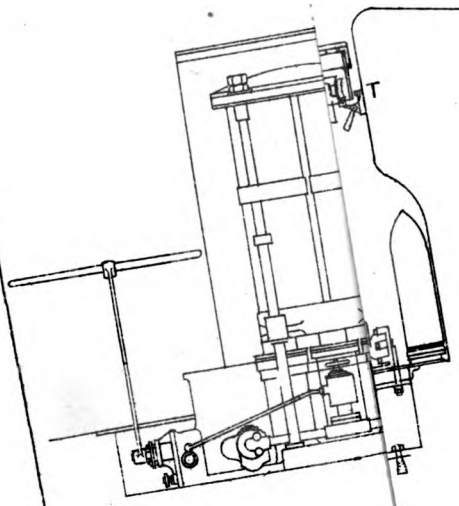
RK IV.





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1605. 2. 04.

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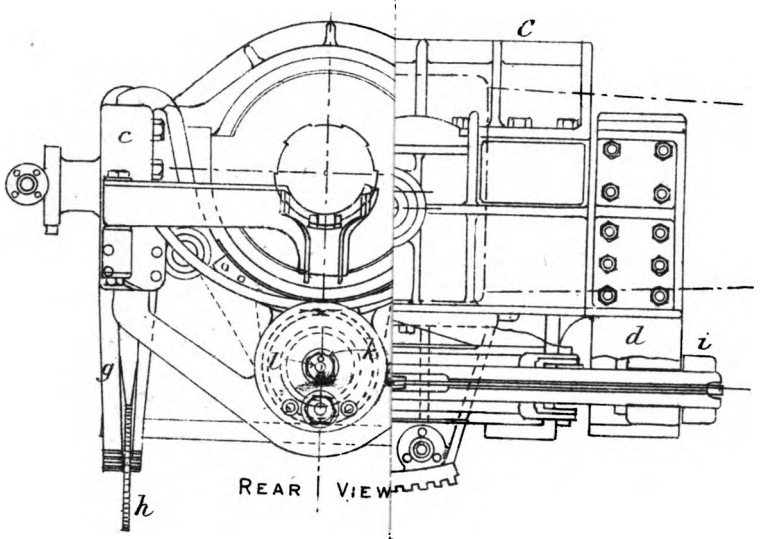
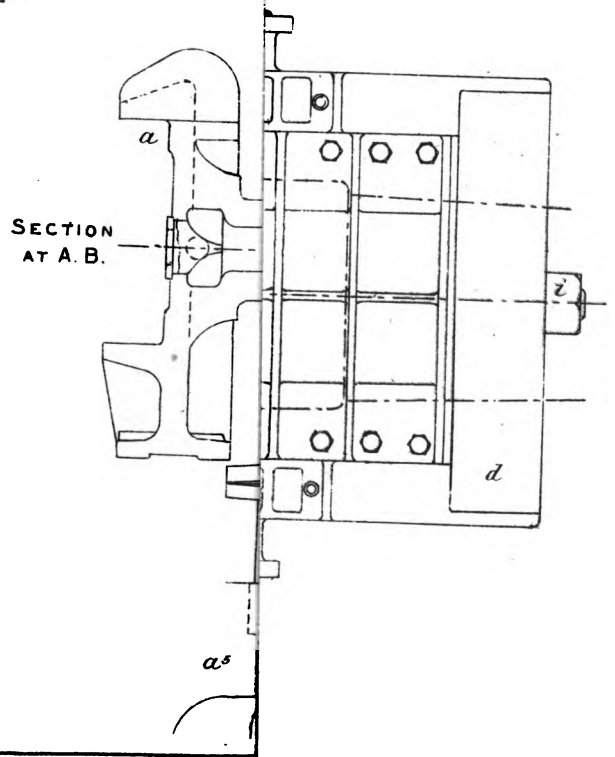
CARRIARK IV, L.





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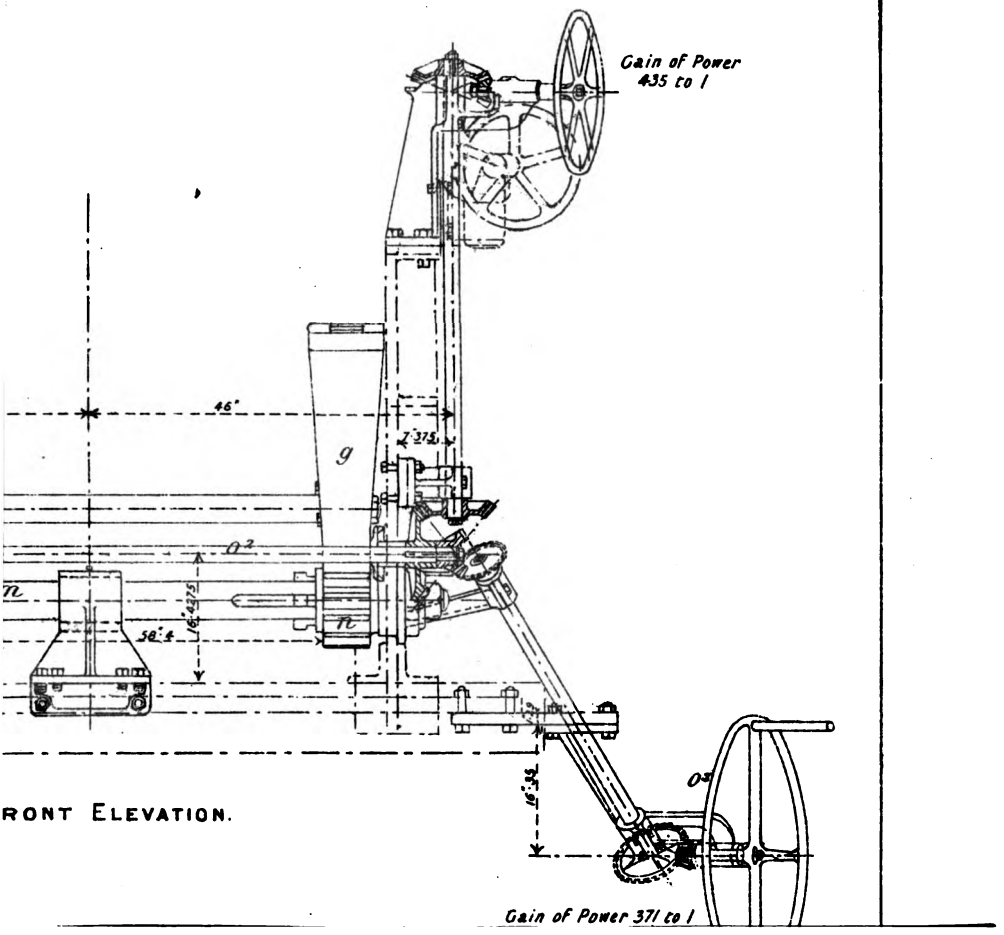
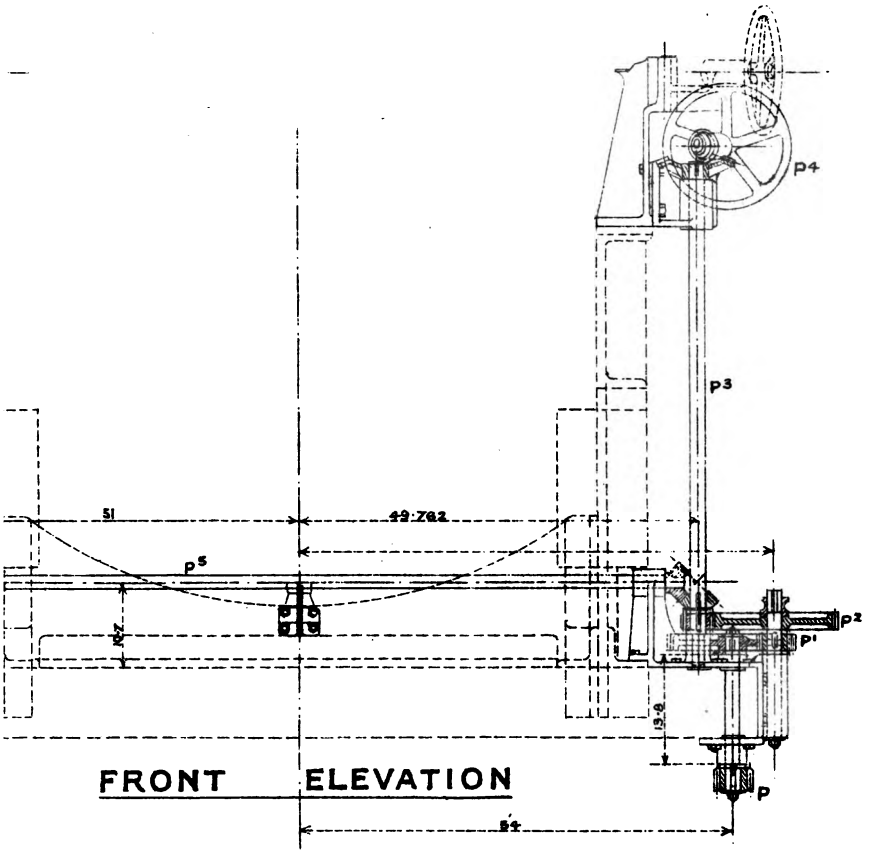


RONT ELEVATION.



FRONT ELEVATION

N BARBETTE, B.L., 10 INCH MARK IV.L.

ANGEMENT OF TRAVERSING GEAR

SCALE 1/24

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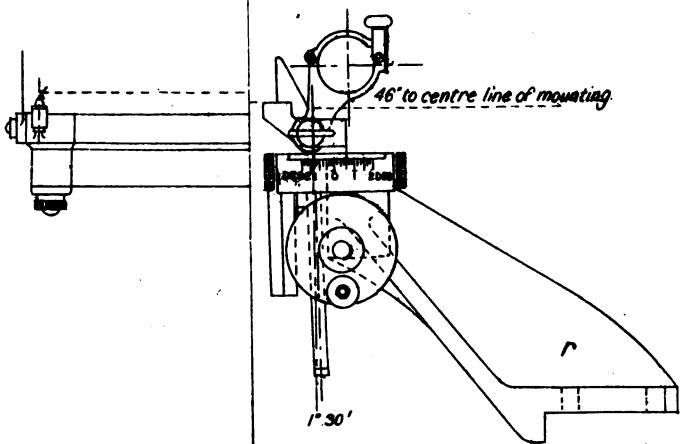
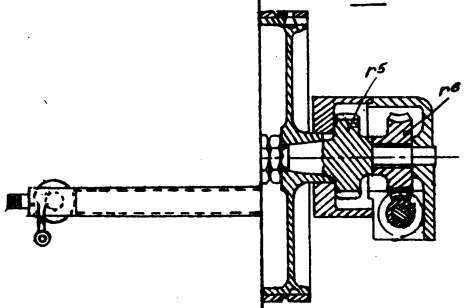
ARK IV).L.



TION THROUGH GEAR.

Scale 1/4



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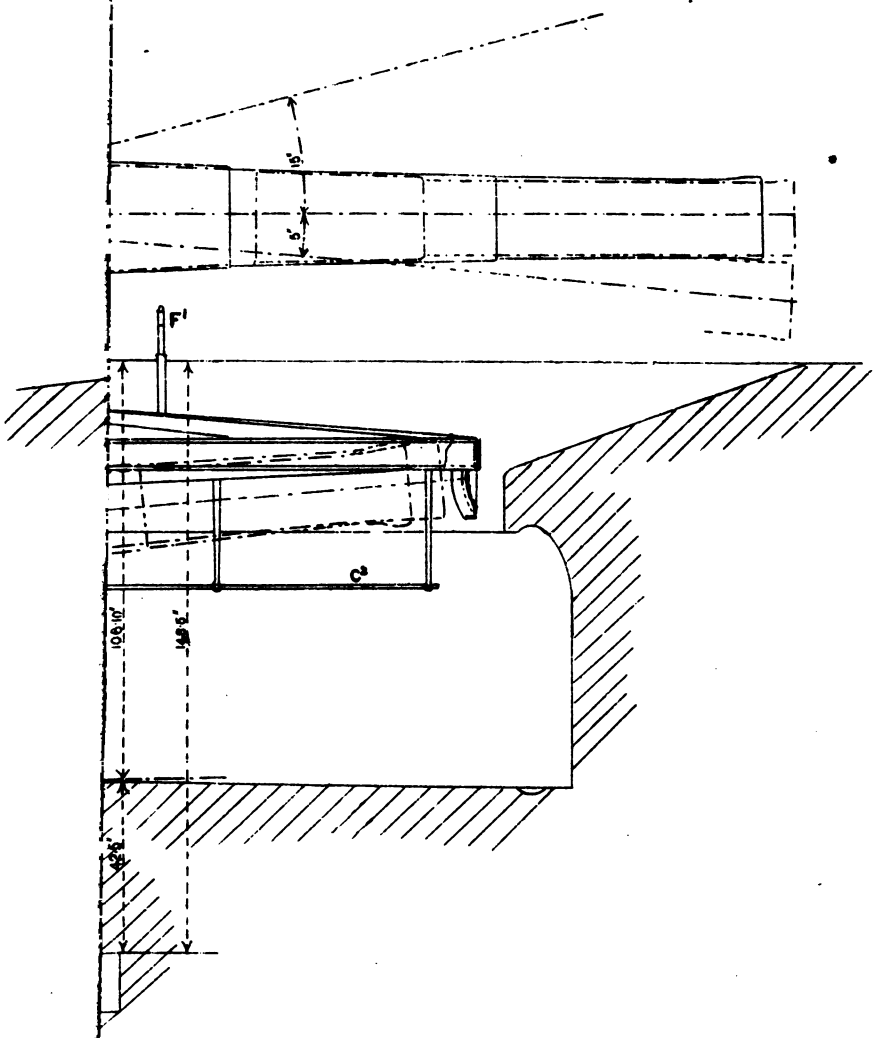

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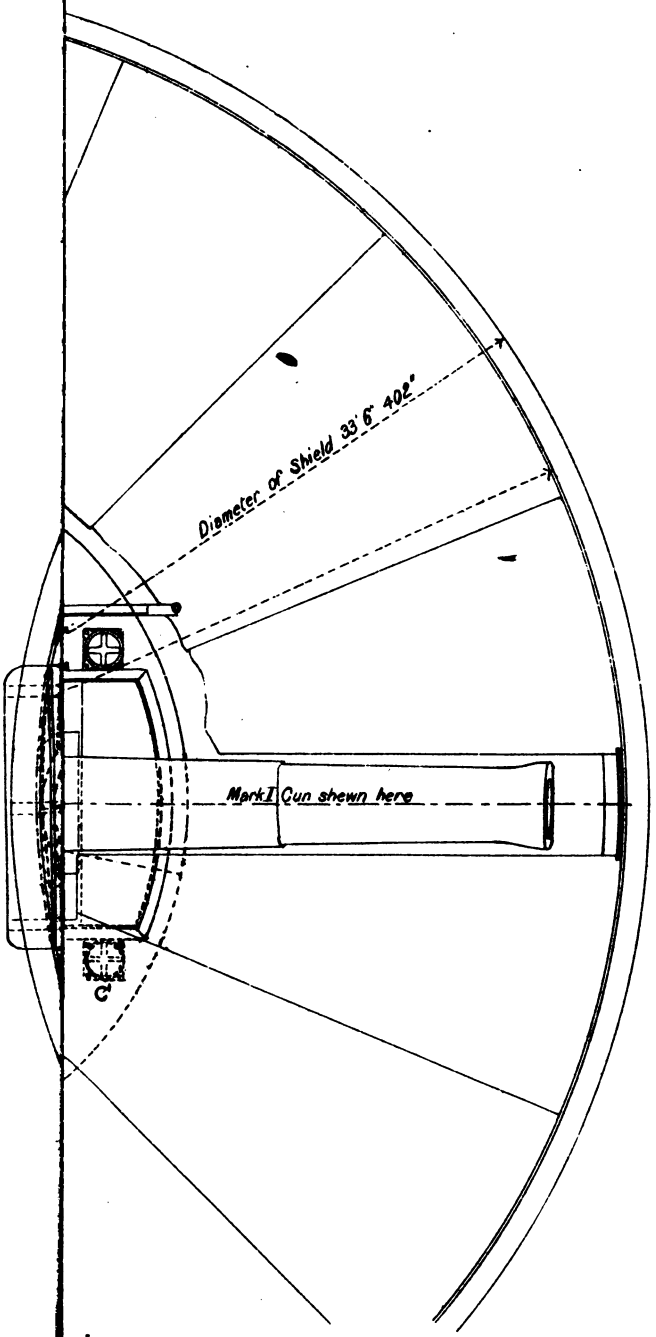
Plate XXVI

IG 10-INCH MARK I



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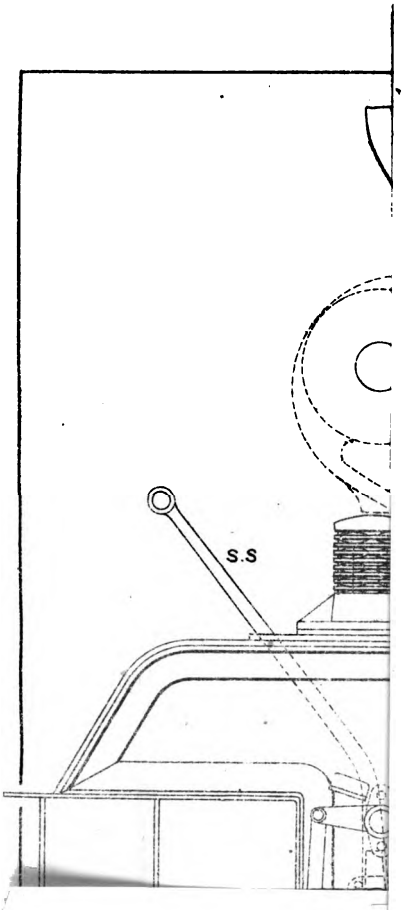

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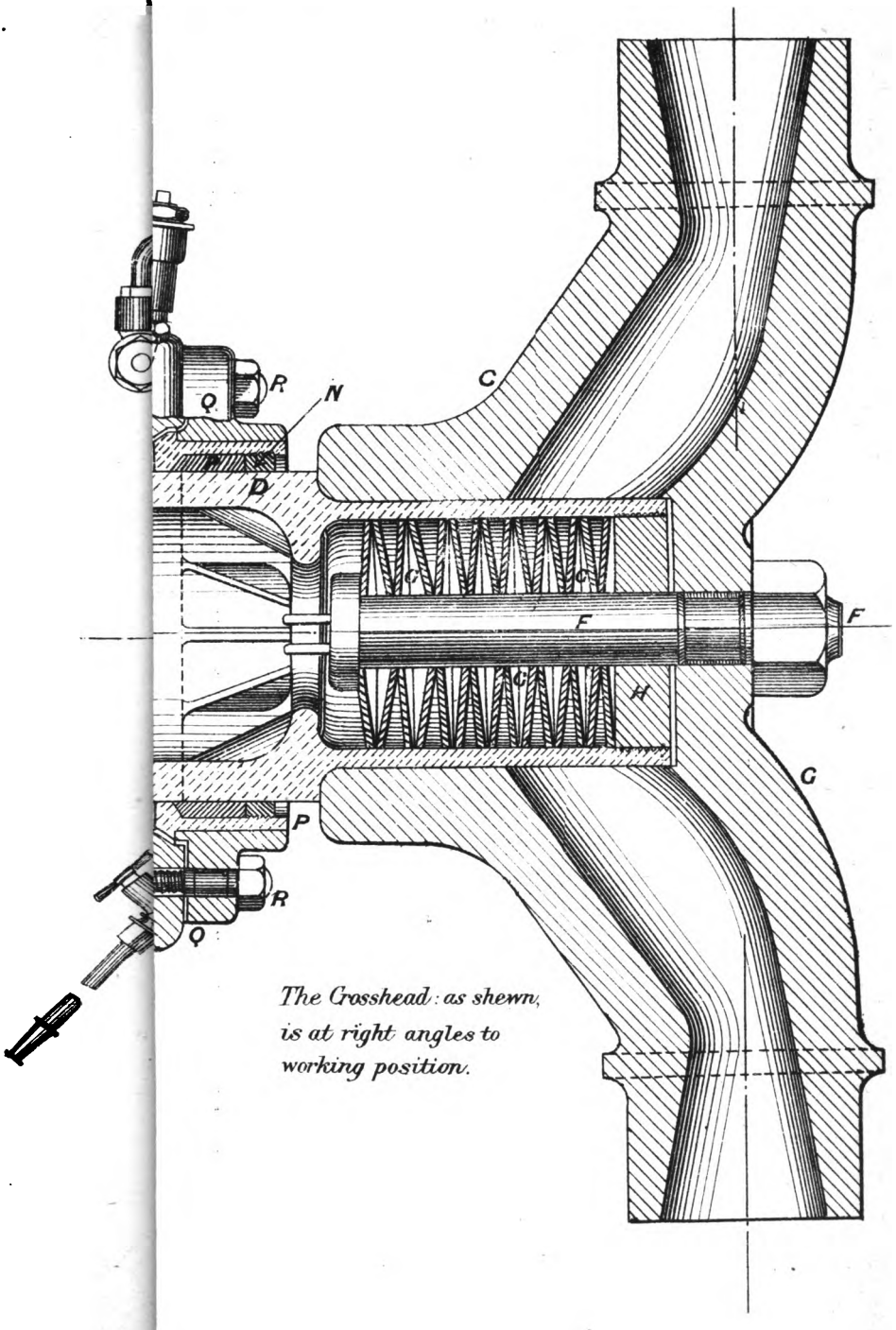
Weller & Graham



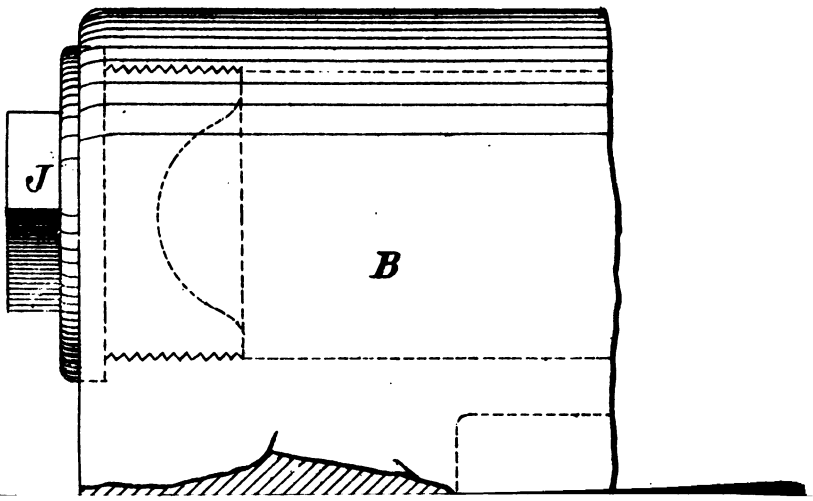
The Crosshead: as shewn, is at right angles to working position.

Mark. I.
„ II.

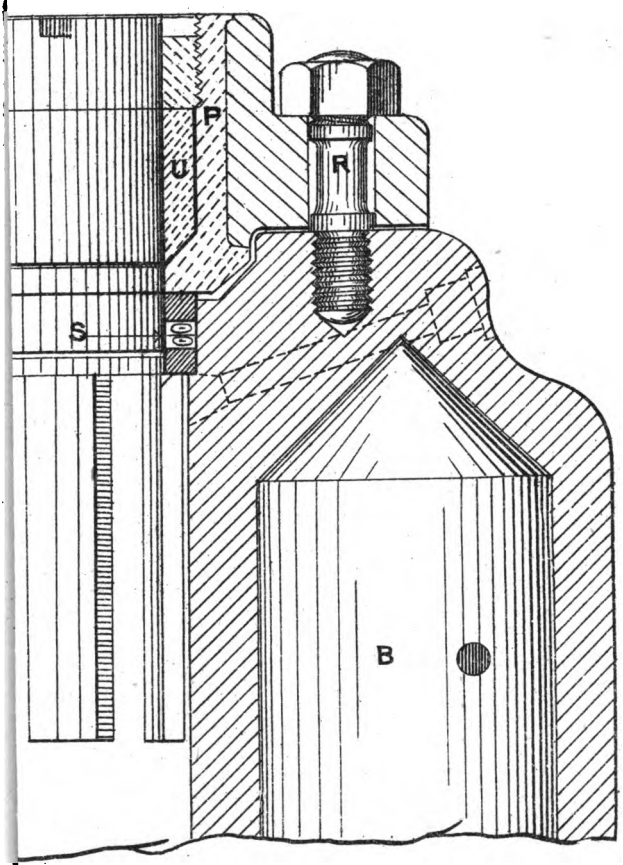
4605. 1.

L., 10-INCH, MARK I.

R.



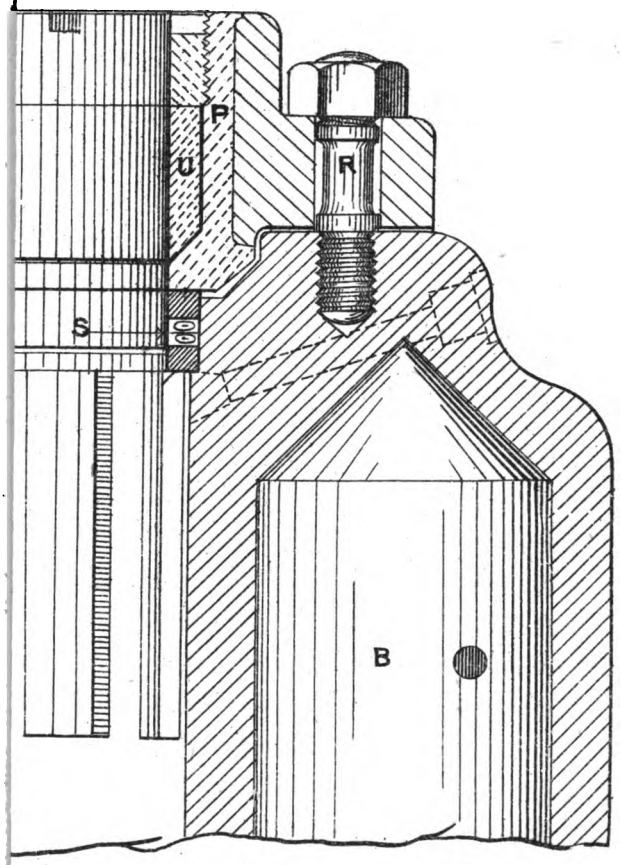
B.L., 10-Inch, Mk I.



R. Studs cover, cylinder recoil.
S Hydraulic packing.
T. Rings packing
U. Ring filling in

4605-1.02

B.L., 10-Inch, Mk I.



R. Studs cover, cylinder recoil.
S Hydraulic packing.
T. Rings packing
U. Ring filling in

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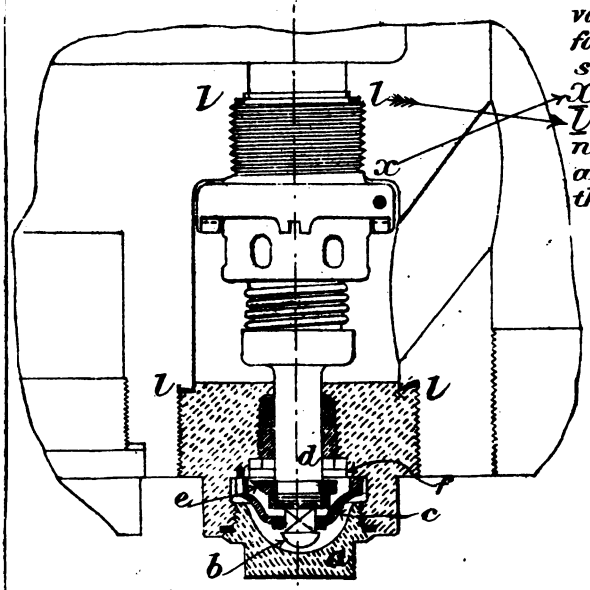
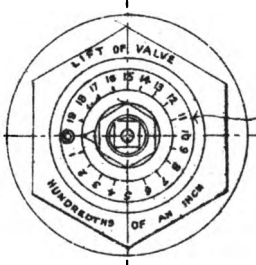
I

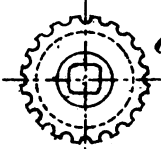
Fig. 3.

RECOIL VALVE, MARK II

NOTE. Marks II* and III valves have a joint for the modified seating at x instead of at l, but this does not affect the adjustment of the valves.







CHECK PLATE

PLAN

with Stop Plate removed.

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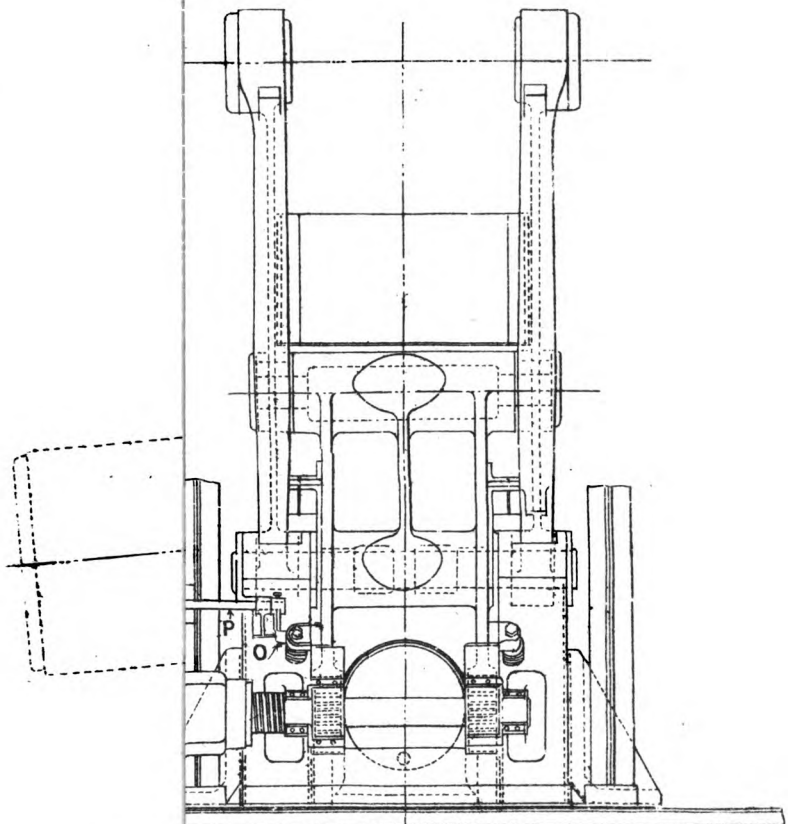


FRONT ELEVATION

4605. 2. 24.

Weller & Graham, Ltd Litho. London

CARRIAGE, GARRISON, DISAPPEARING, B.L. 10 INCH, MARK II.

PLAN

SCALE 1/64

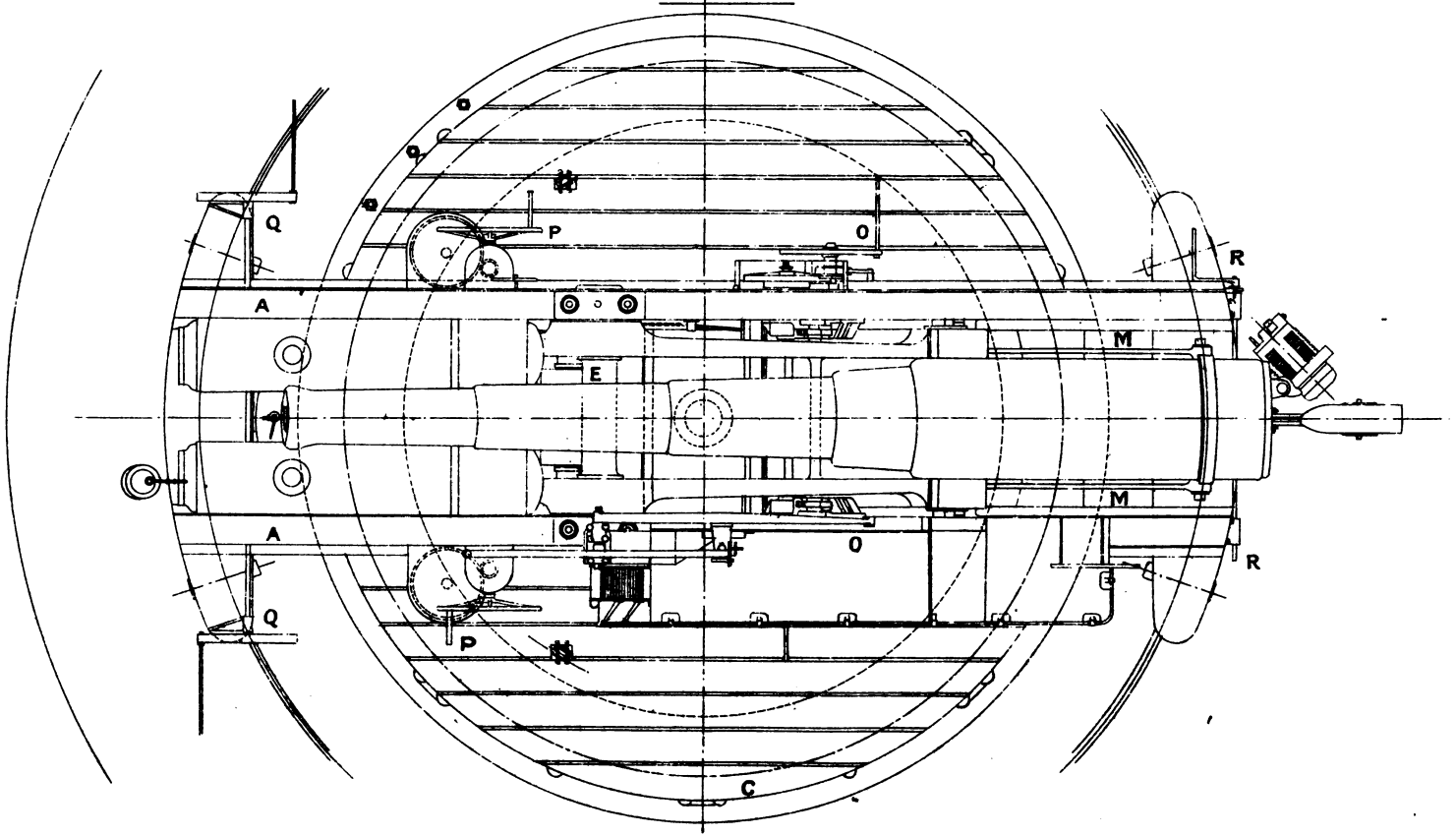


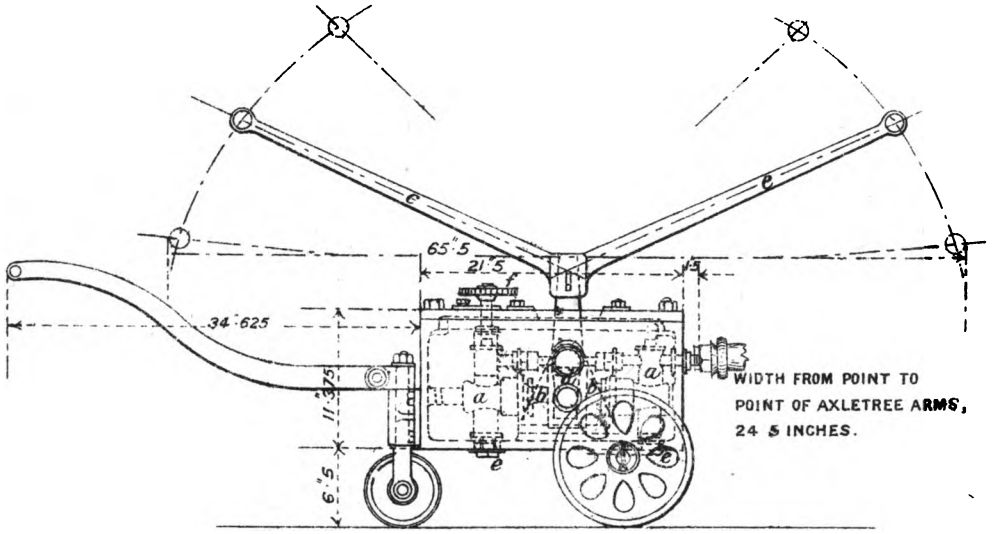
Plate XXXV.

Weller & Graham, Ltd Litho. London

PUMP, RUNNING BACK, PORTABLE, MARK I.

WITH STOP VALVE "A"; CARRIAGES, GARRISON, B.L., 12-INCH; BARBETTE 10 INCH, MARK IV, AND 9·2 INCH, MARKS III, IV & V

SCALE 1/16.

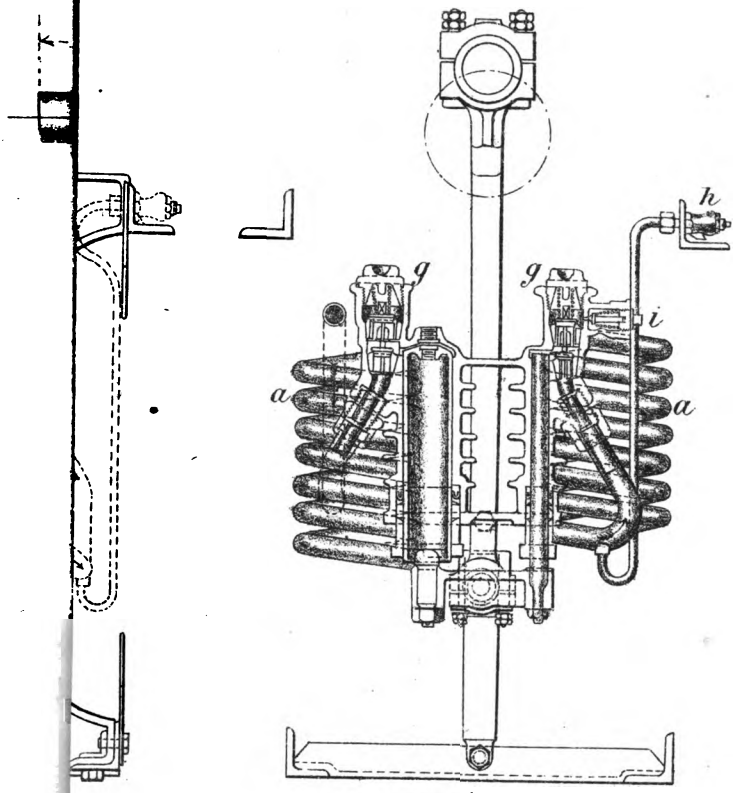


SIDE ELEVATION.

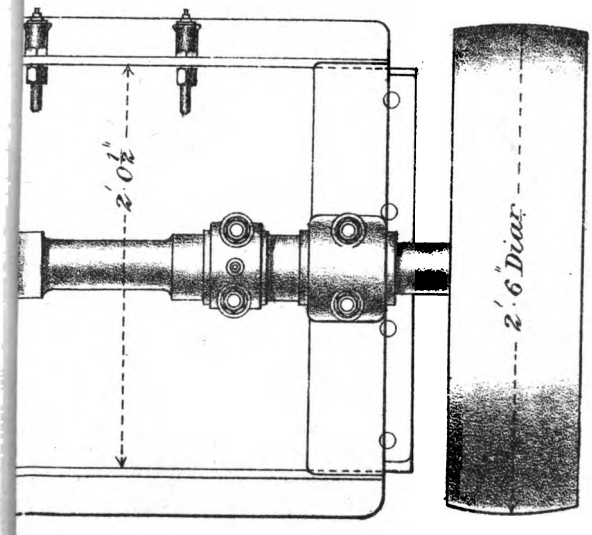
Weller & Grahams, Ltd Litho. London.

K I.

UNTINGS AND BALLONS.



SECTION ON LINE E.F.



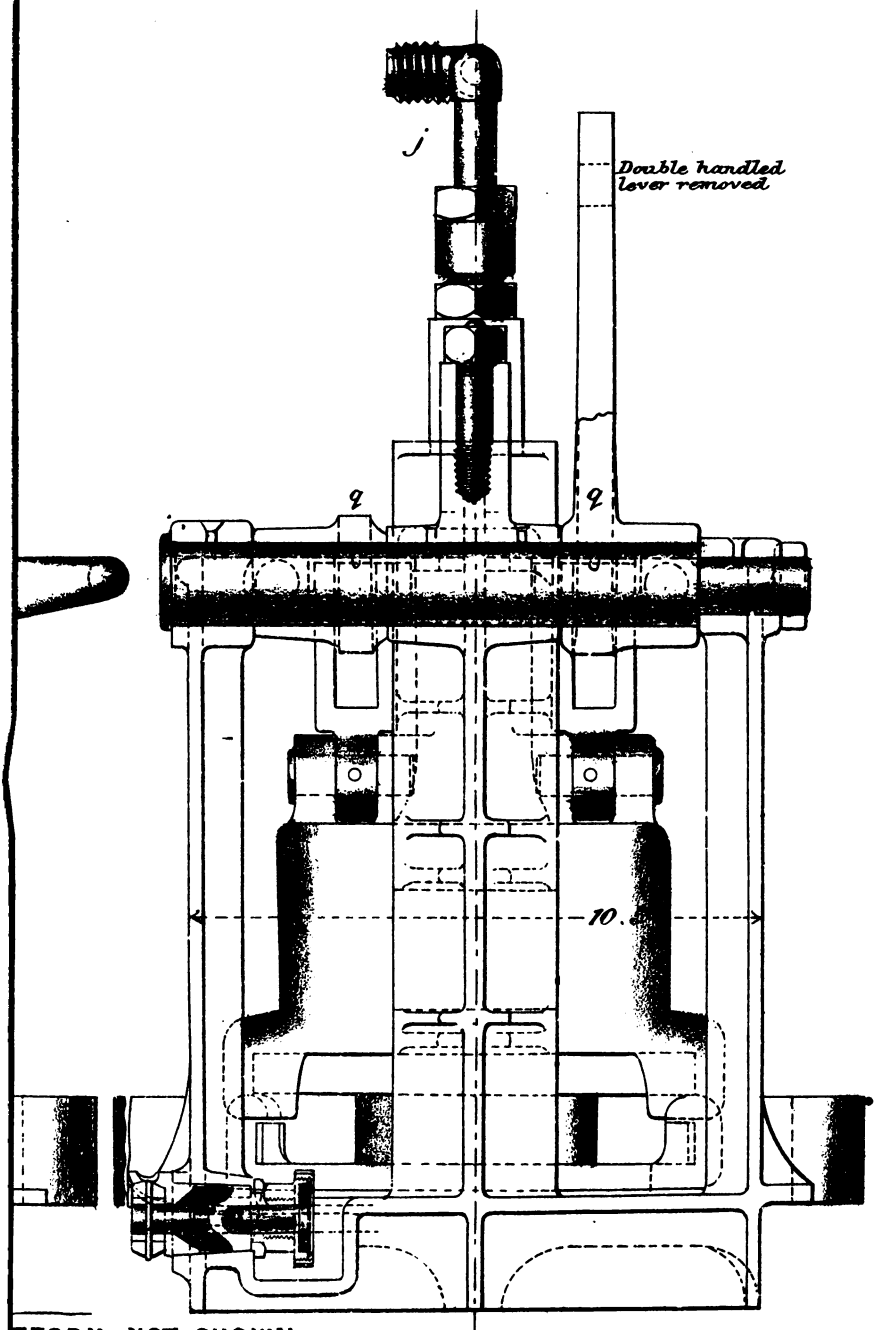
TOP PLAN.

3 4 FEET.

5.1.04.

ARK I.

O;) CHARGING RESERVOIRS, AND HYDRO-PNEUMATIC MOUNTINGS.



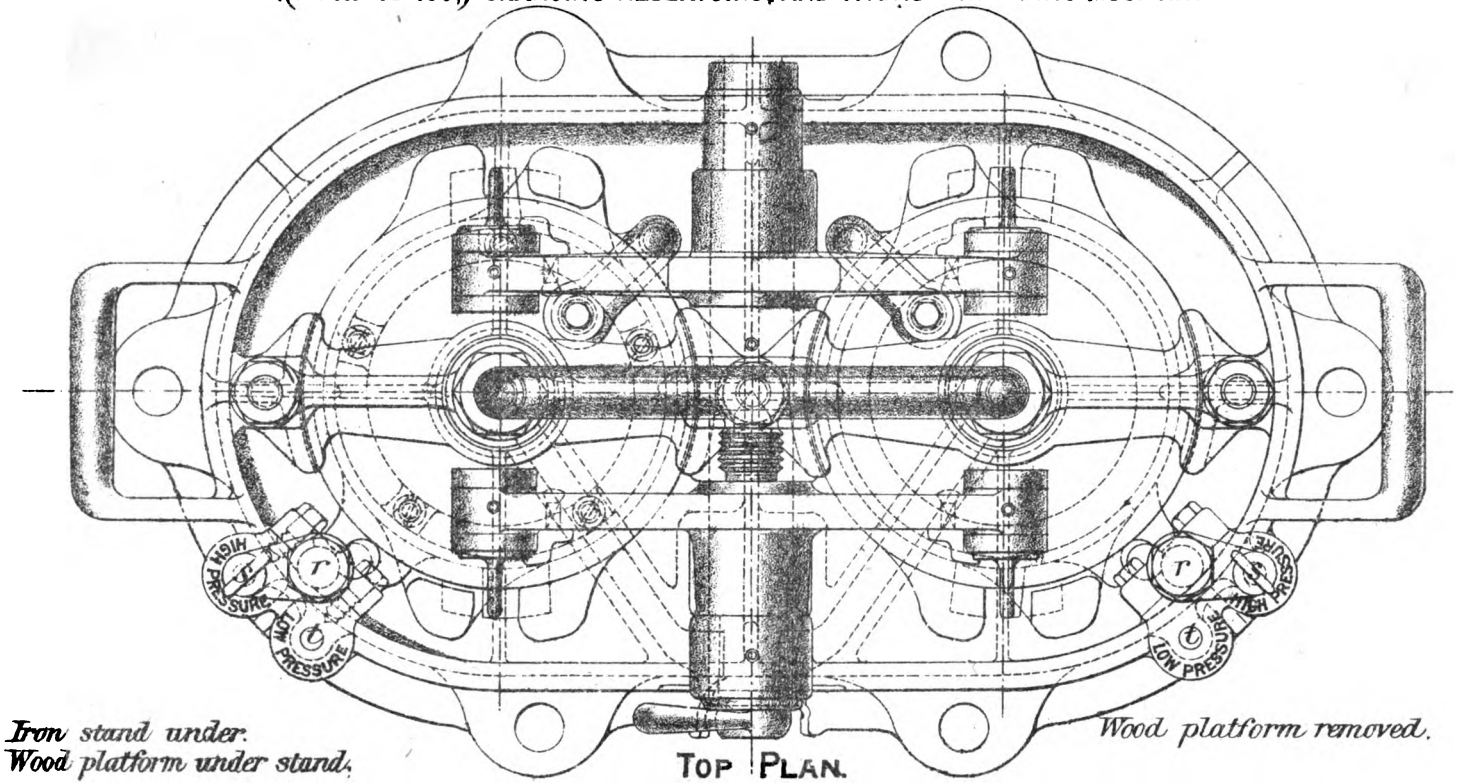
TFORM NOT SHOWN.

END ELEVATION.

10 11 12 inches

PUMP, AIR OR LIQUID, MARK I.

WITH STAND, 4 CONNECTING PIPES, 4 ADAPTERS (1 "A" AND 3 "B",) AND 4 SPANNERS (Nos. 157 TO 160;) CHARGING RESERVOIRS, AND HYDRO-PNEUMATIC MOUNTINGS.



Iron stand under.
Wood platform under stand.

Wood platform removed.

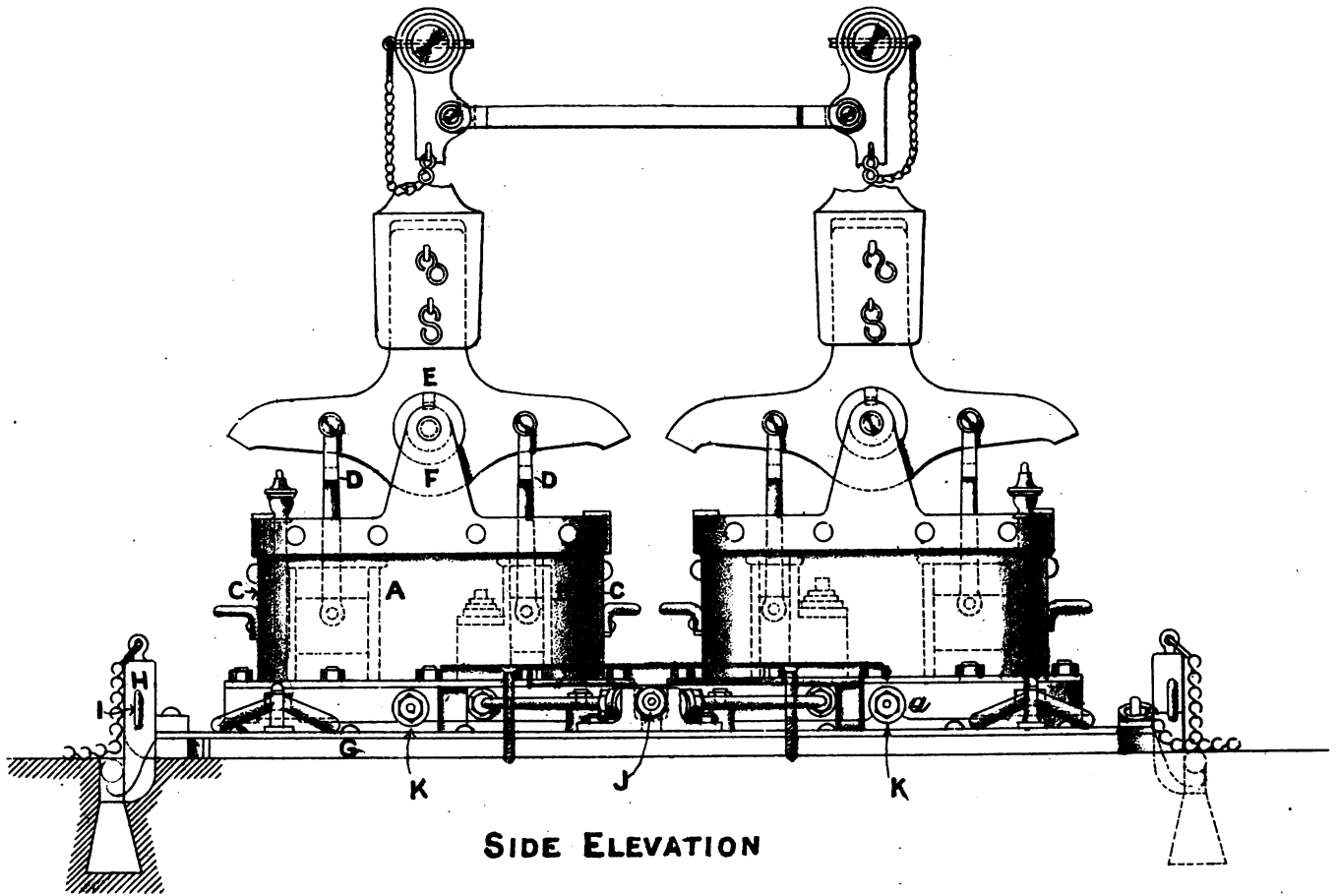
TOP PLAN.

SCALE.

1 2 3 4 5 6 7 8 9 10 11 12 INCHES.

Plate XXVII.

PUMP, AIR, DOUBLE, MARK I.



SIDE ELEVATION

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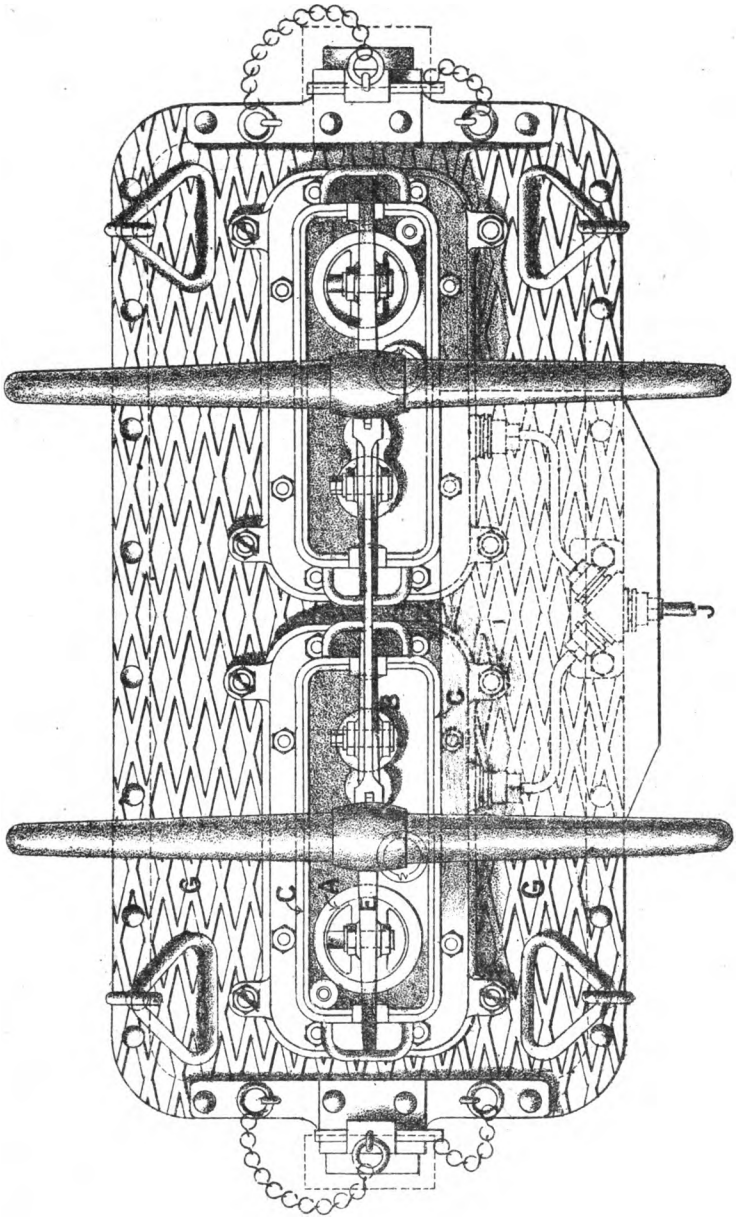
Pump, Air, Double, Mark I.



Top Plan.

Weller & Graham, Lith. London

RS (MARK I)

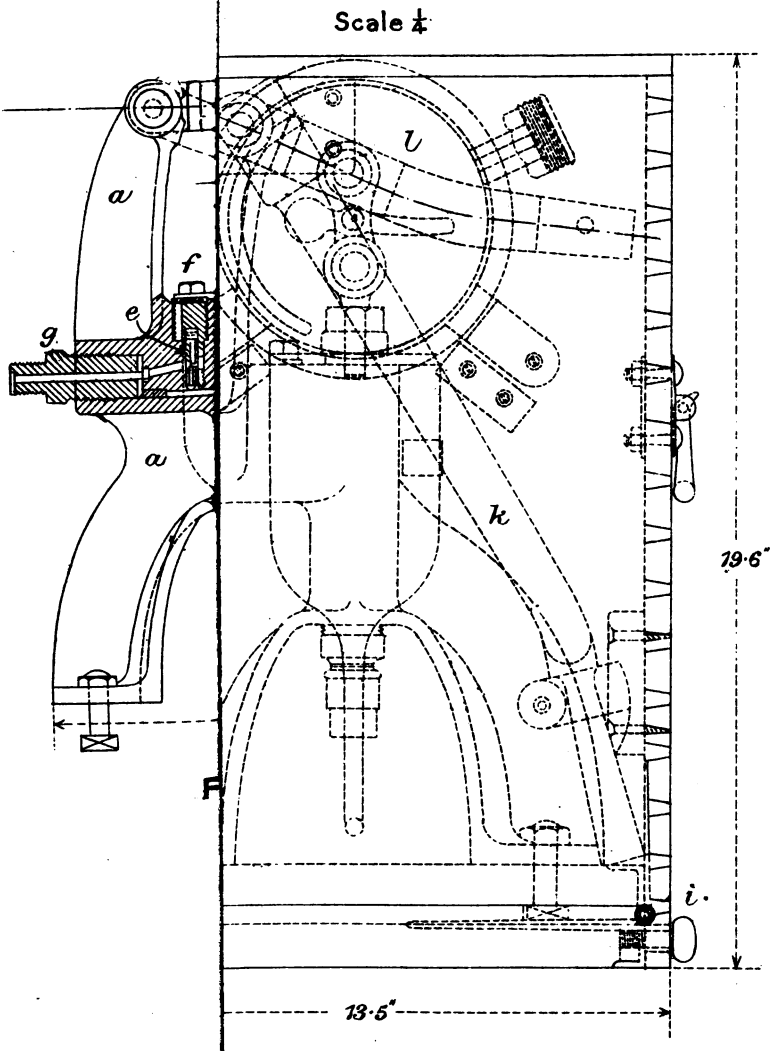


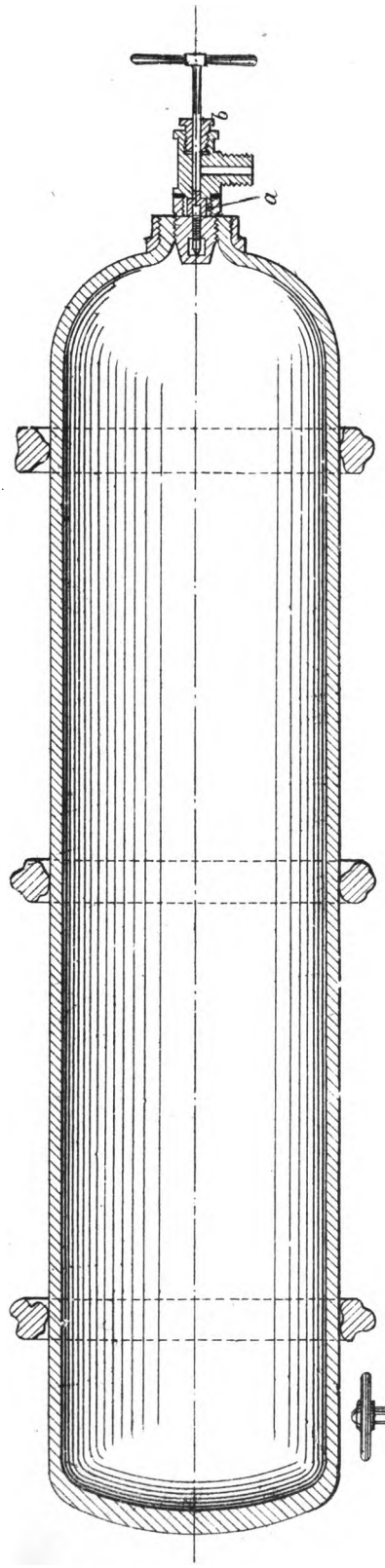
FIG. 3.

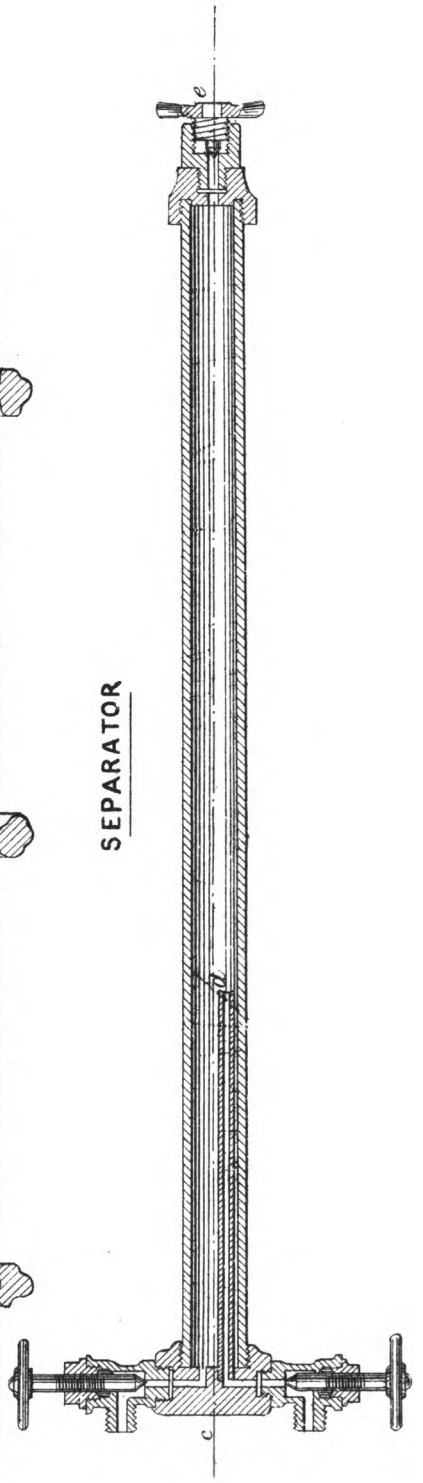
4605. 1. 04.

Weller & Graham, Ltd Litho. London.

Reservoir for Compressed Air.

Mark II.

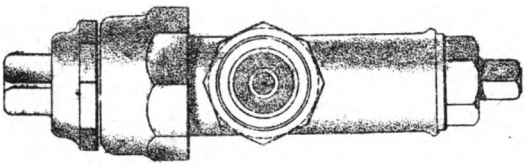


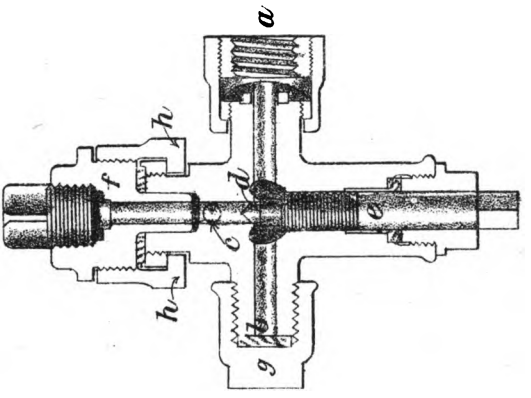


SEPARATOR

Waller & Graham, Ltd. Litho London

Connection, Pressure Gauges.





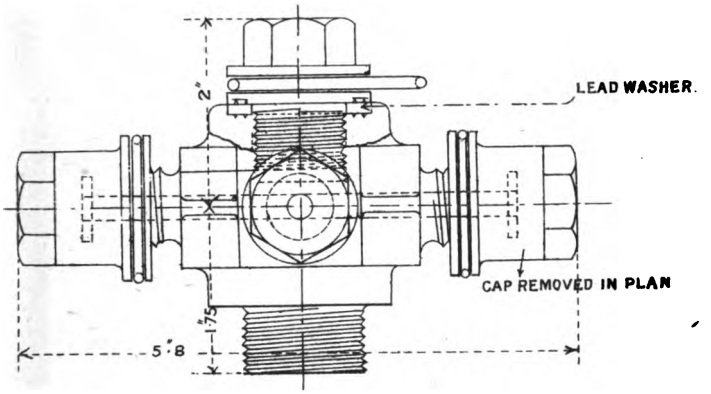
4008.1.04.

Weller & Grahams Ltd Litho London.

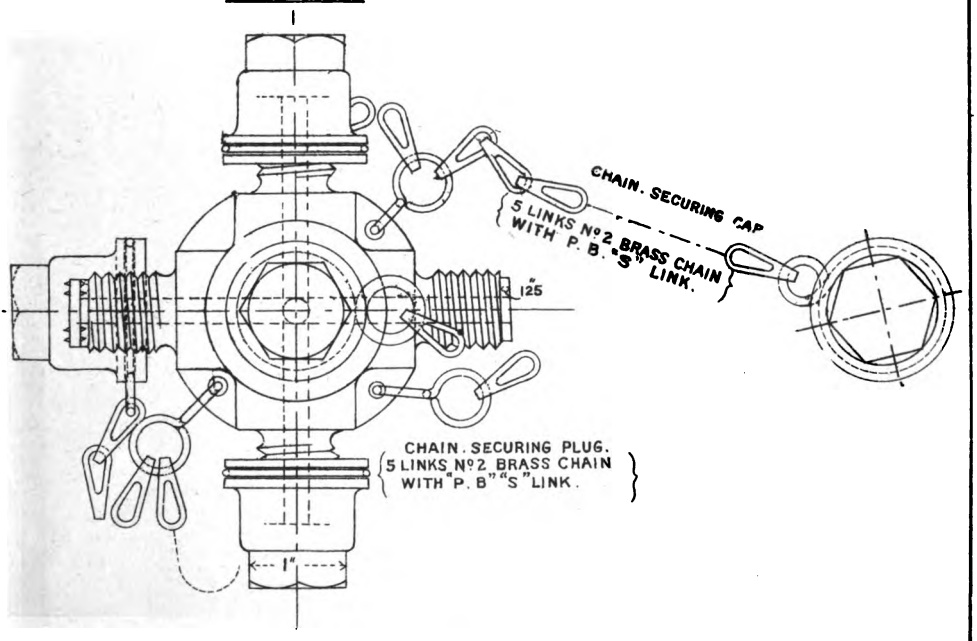
CONNECTION, FOUR-WAY, AIR PUMP, MARK I.

HALF FULL SIZE.

ELEVATION.



PLAN.



1905.1.04.

Weller & Graham Ltd Litho. London.

RE.

No. 3.

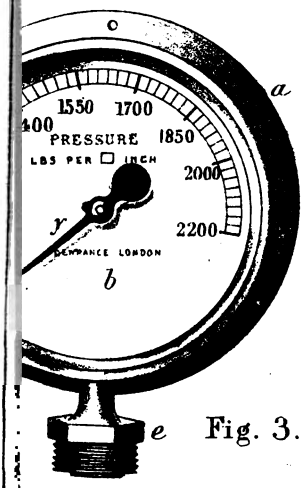


Fig. 3.

No. 4.

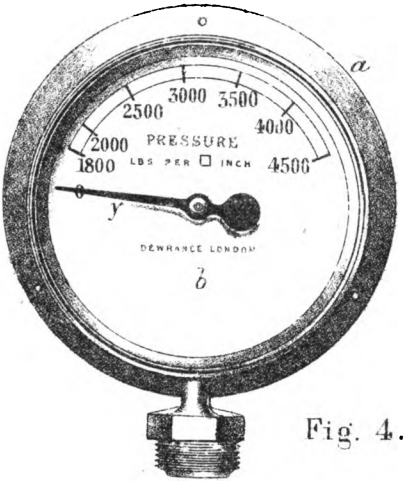


Fig. 4.

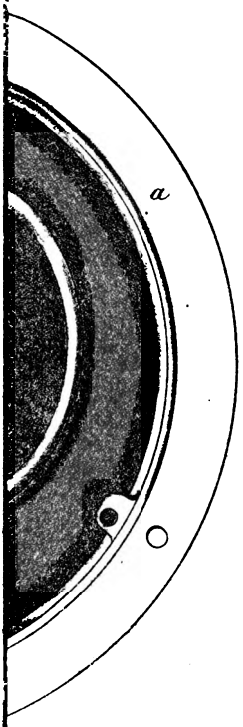


Fig. 5.

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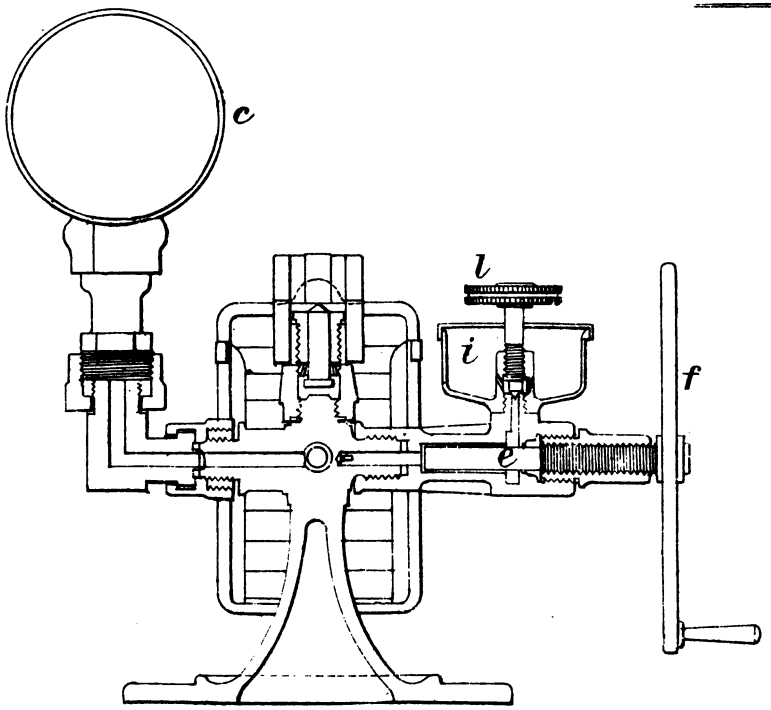
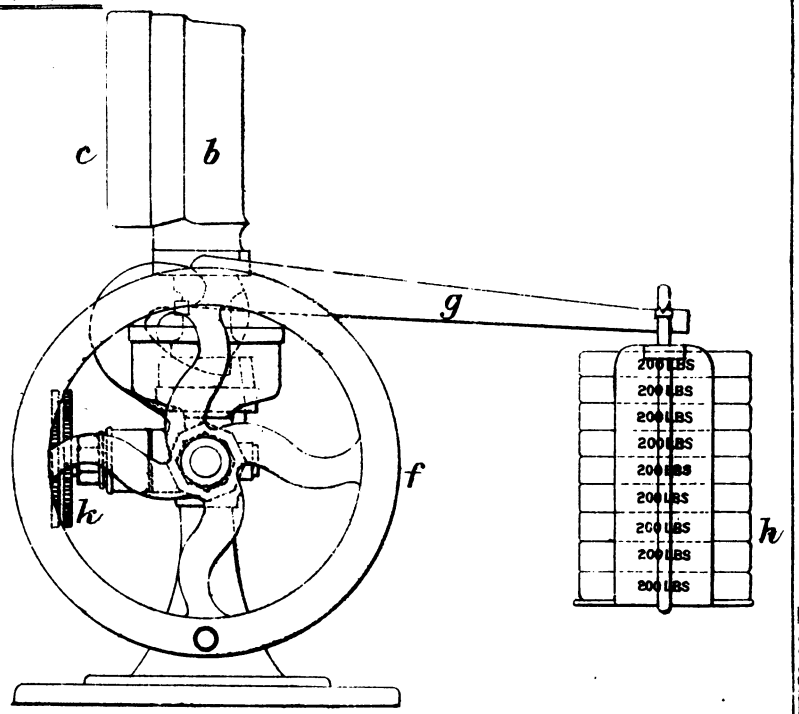
4605.104.

GAUGE, PRESSURE. DEAD WEIGHT, TESTING, MARK II.

SCALE ¼.

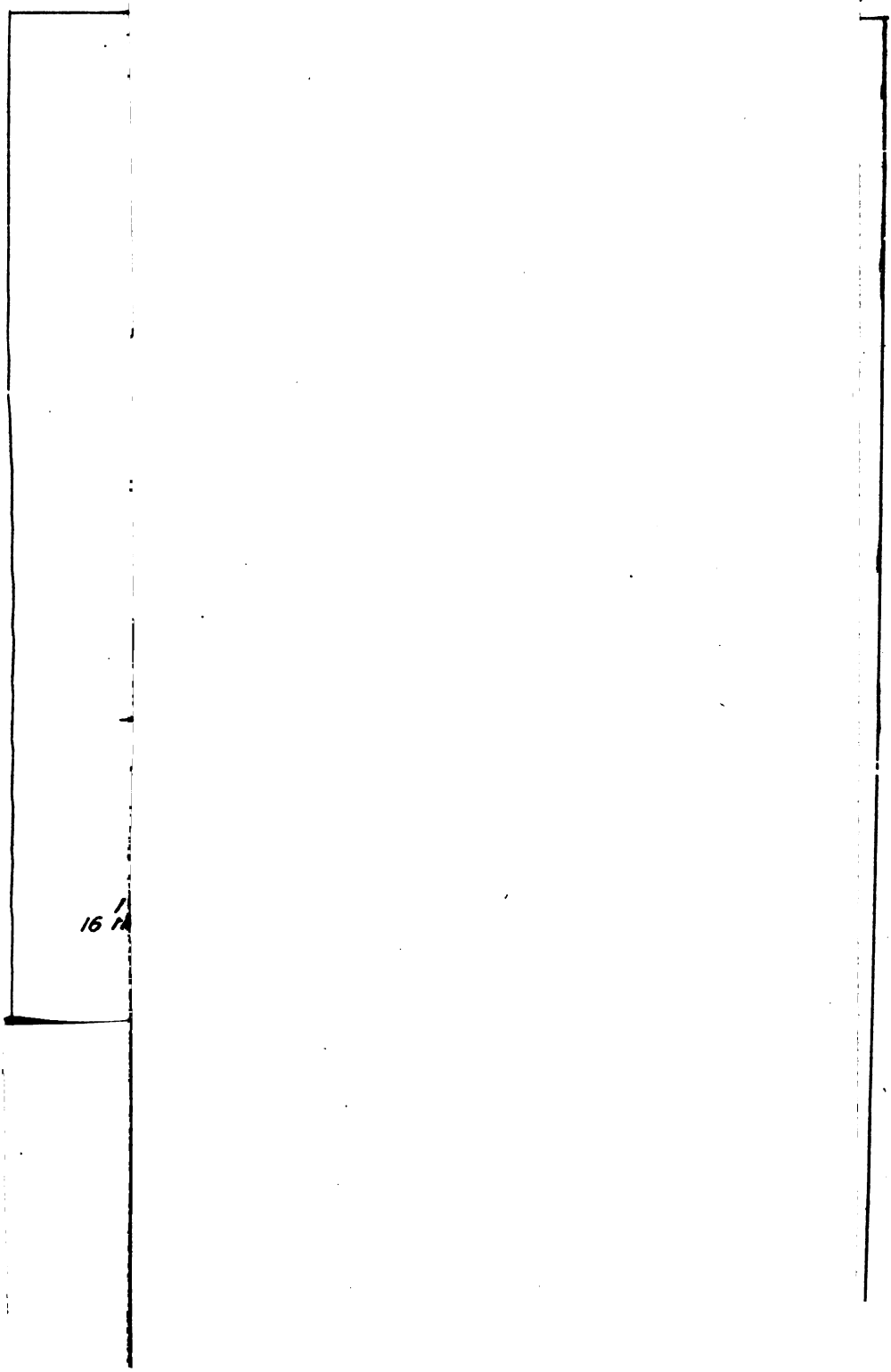


SECTIONAL ELEVATION.



END ELEVATION.

Plate XLV.



NOT TO EXCEED

PLAN.

WITH PART OF TOP DISC REMOVED

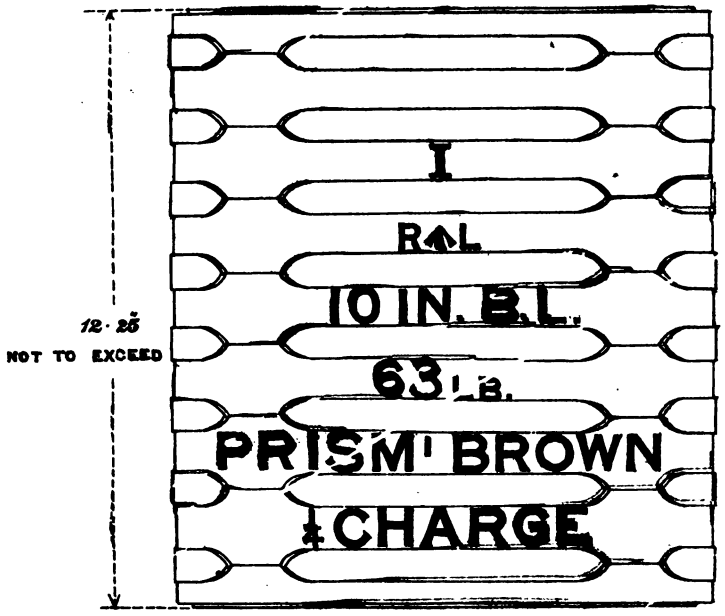
4865.1.64

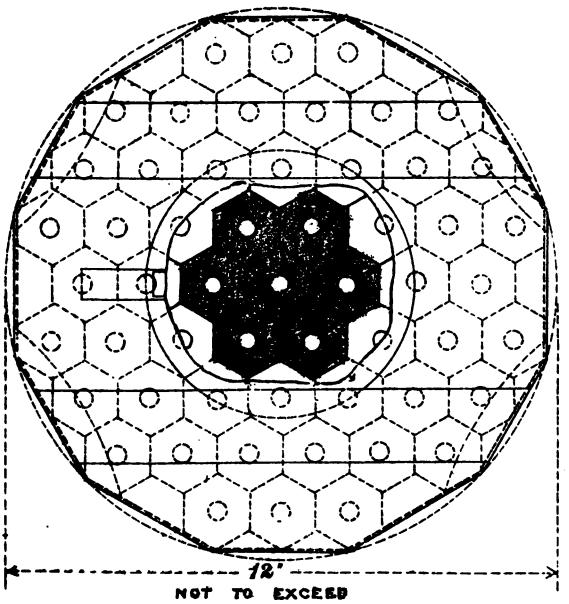
Walker & Graham & Co. Ltd.

CARTRIDGE, B.L., 10-INCH., 63 LB. PRISM[L] BROWN, MARK I.

SILK CLOTH, ¼ CHARGE, PRIMED WITH PRISM BLACK.

Scale ¼.

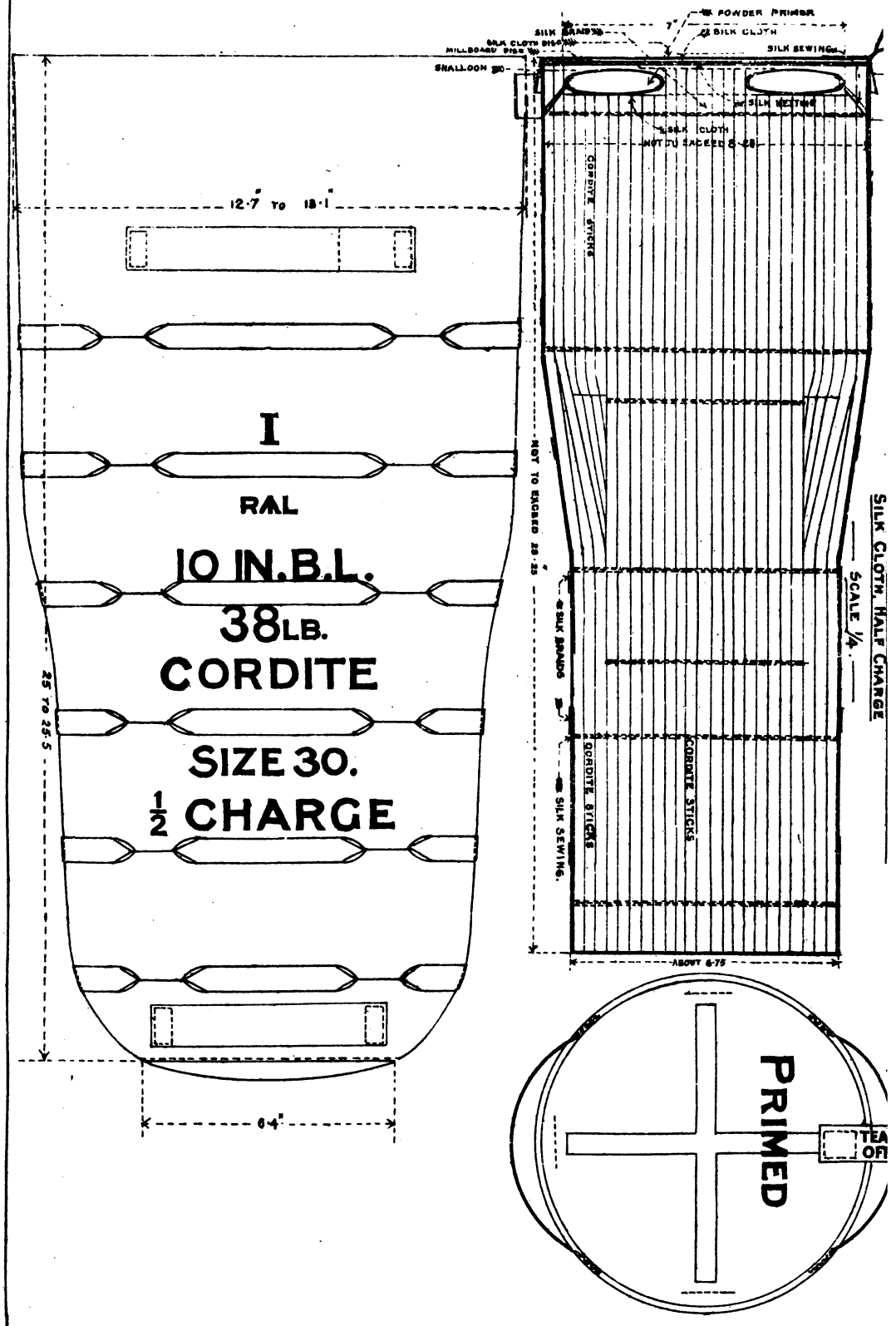




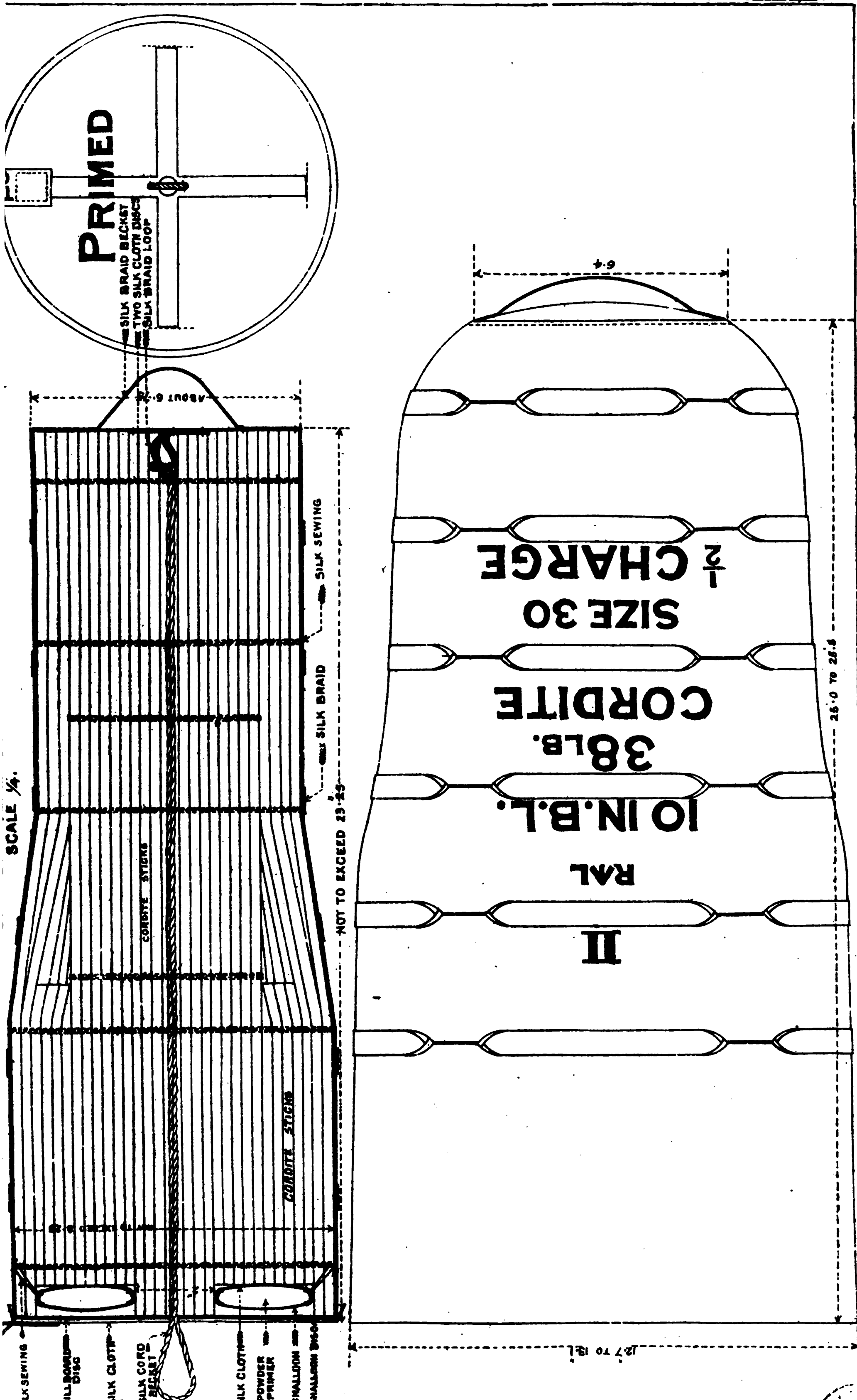
PLAN.

WITH PART OF TOP DISC REMOVED

Weller & Graham [illegible] Lon[illegible]



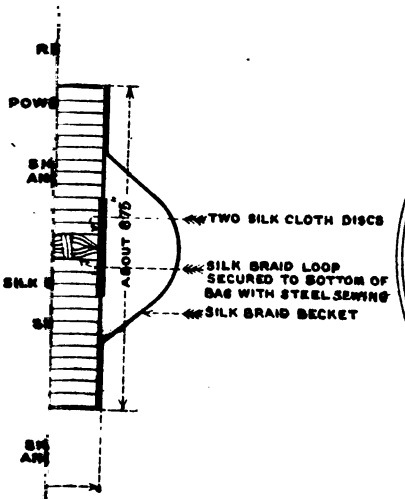
E. Weller & Grahams Ltd Litho Londo

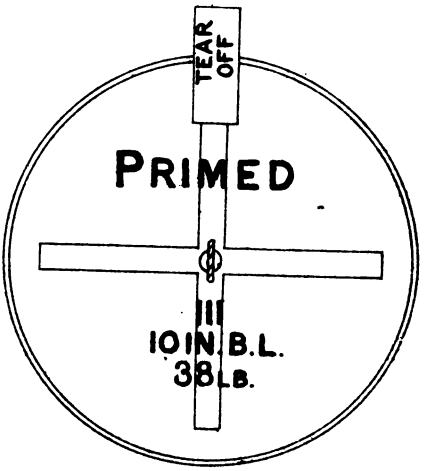


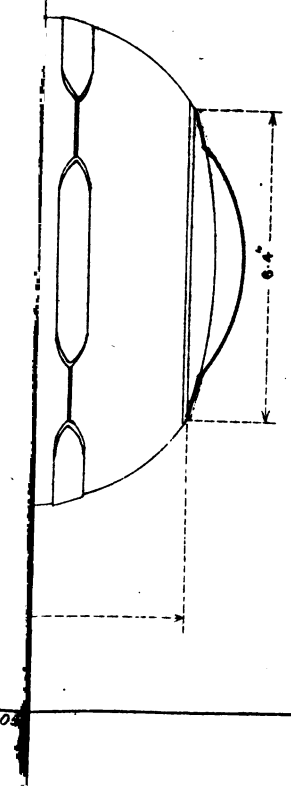
Weller & Graham Ltd Litho

) MARK

) MARK III



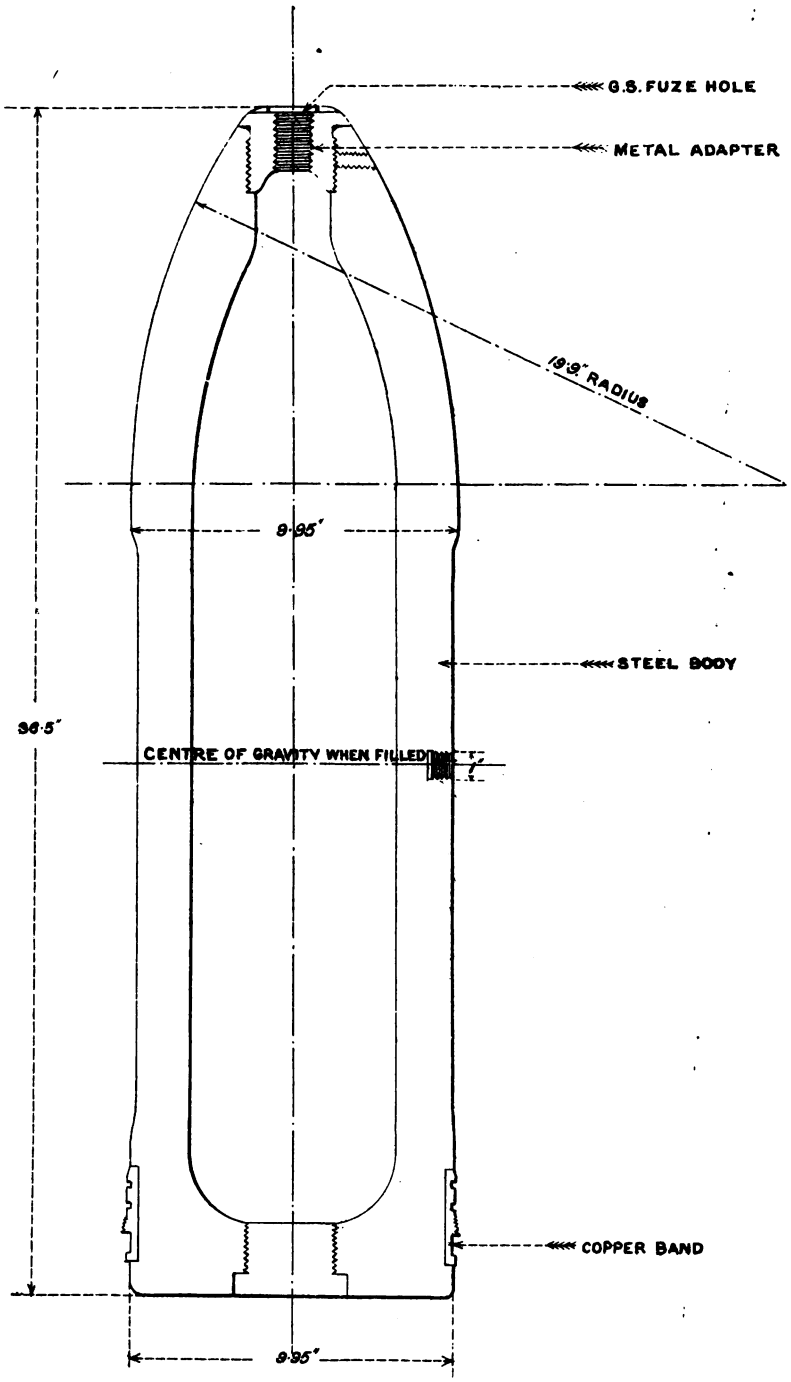




Weller & Graham. Ltd Litho. London

SHELL, B. L. COMMON, 10-INCH, CAST STEEL – MARK II

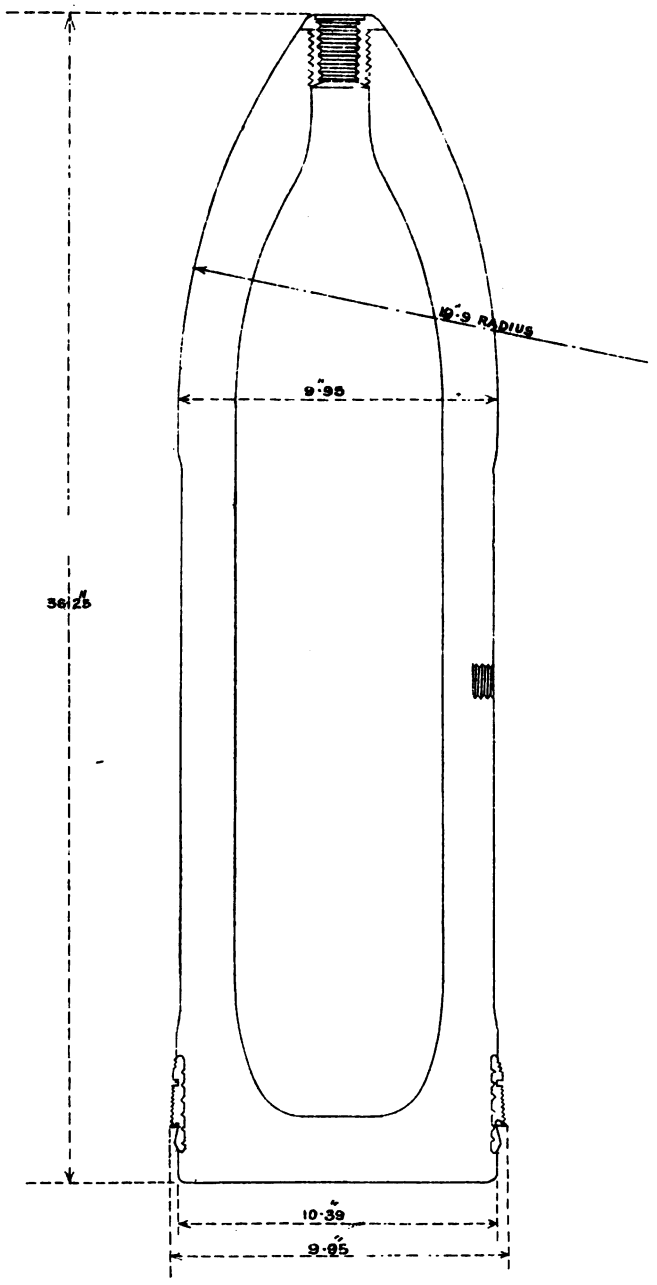
Scale $\frac{1}{6}$



SHELL, B.L. COMMON LYDDITE, 10 INCH, MARK II.

FORGED STEEL.

SCALE 1/6.

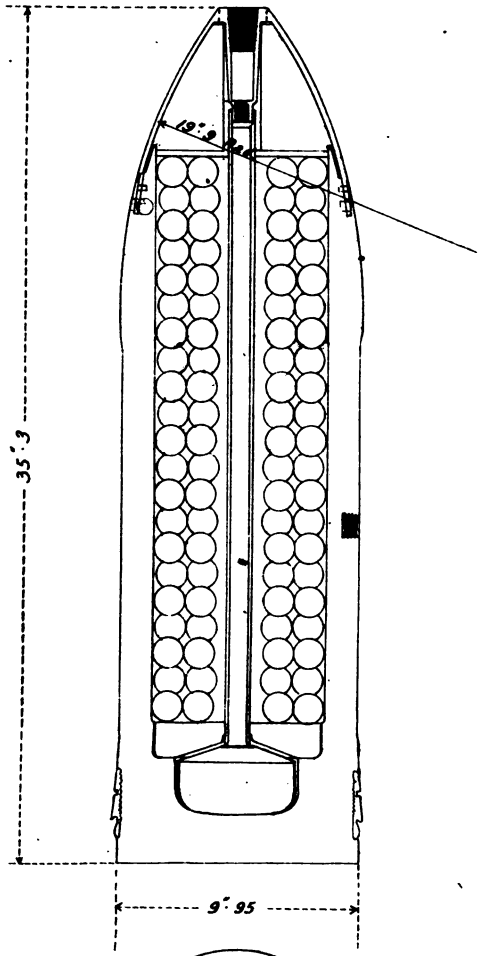


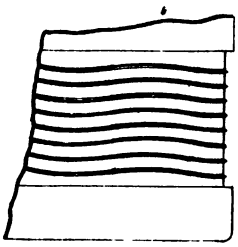
4605. 1. 04

Weller & Graham, Ltd. Litho. London.

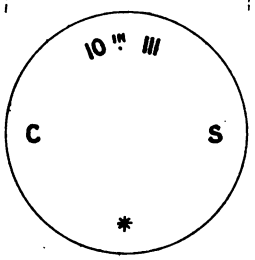
SHELL, B. L. SHRAPNEL, 10 INCH, CASE STEEL, (MK. III) |C|.

1/8 SCALE.





PART DEVELOPMENT OF SHELL SHEWING WAVED RIBS — 10 WAVES.



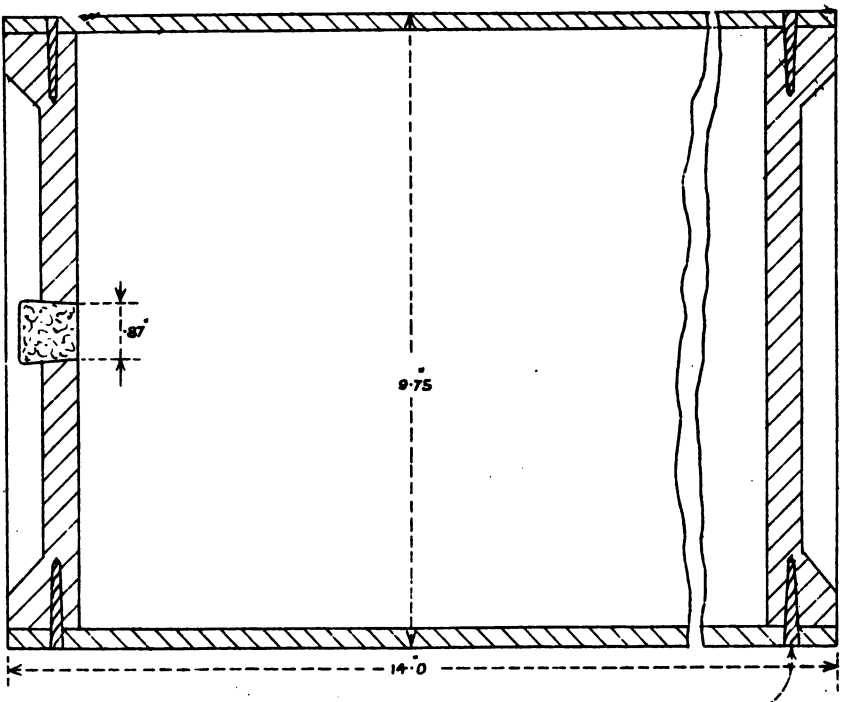
PLAN OF BASE.

4683. X. 06.

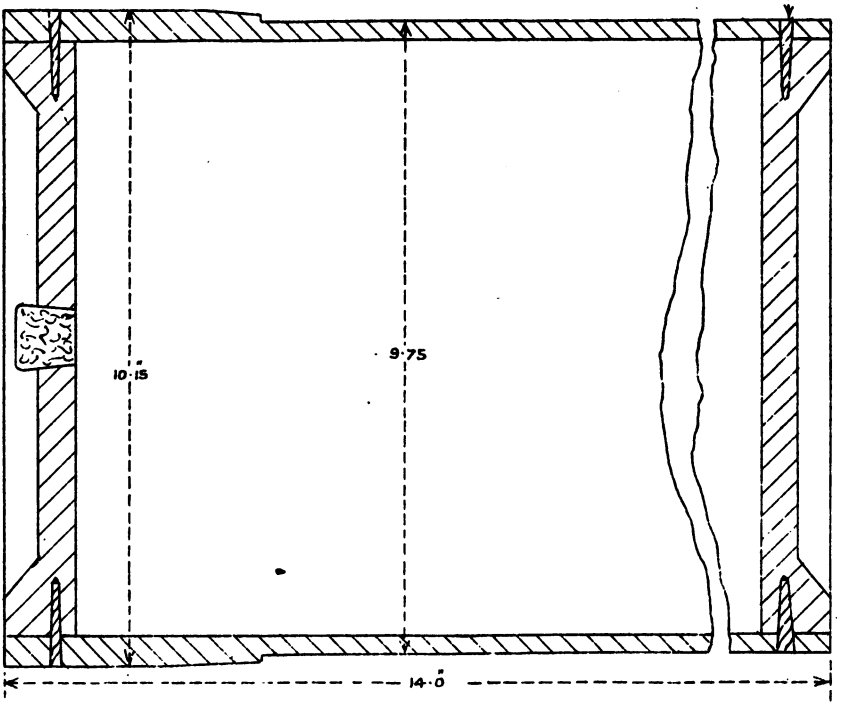
Weller & Graham, Ltd Litho, London.

SHOT. B.L. PAPER, EMPTY, 10 INCH, FRONT & REAR, MARK IV

FRONT



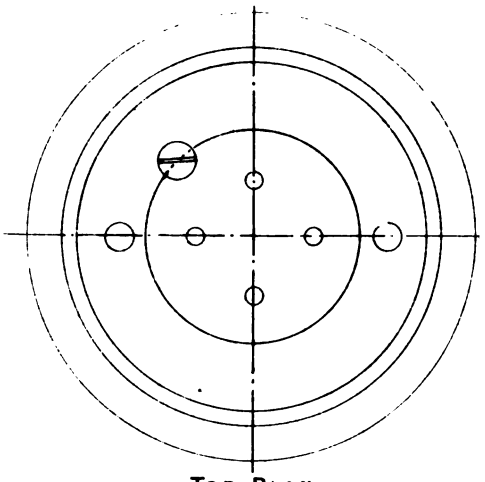
REAR



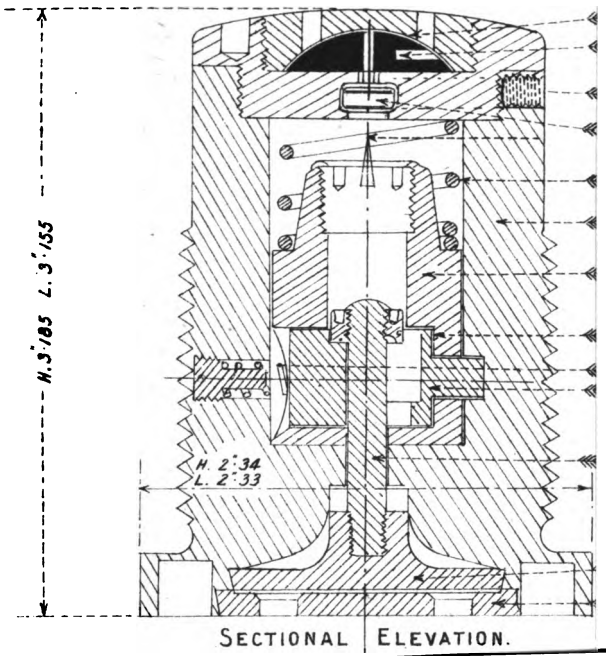
Weller & Graham, Ltd. Litho. Lond.

FUZE, PERCUSSION, BASE, LARGE

FULL SIZE.



TOP PLAN.



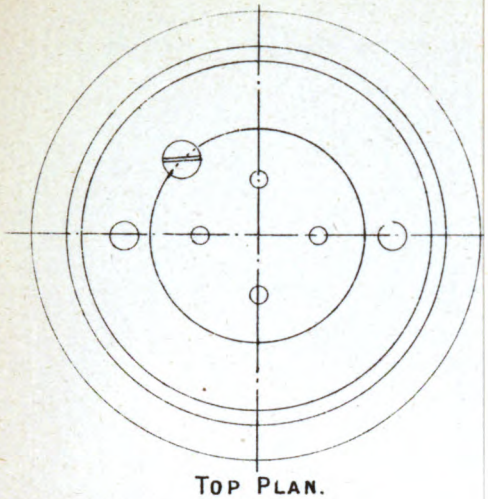
SECTIONAL ELEVATION.

4605.1.04.

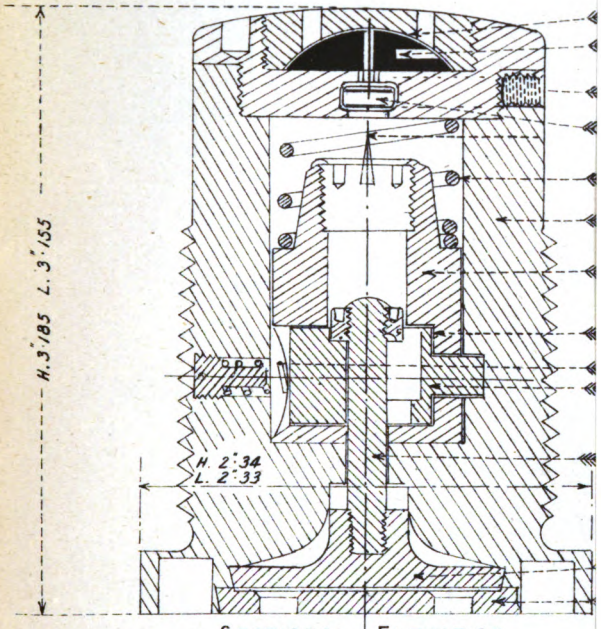
Weller & Graham, Ltd Litho. London.

FUZE, PERCUSSION, BASE, LARGE

FULL SIZE.



TOP PLAN.



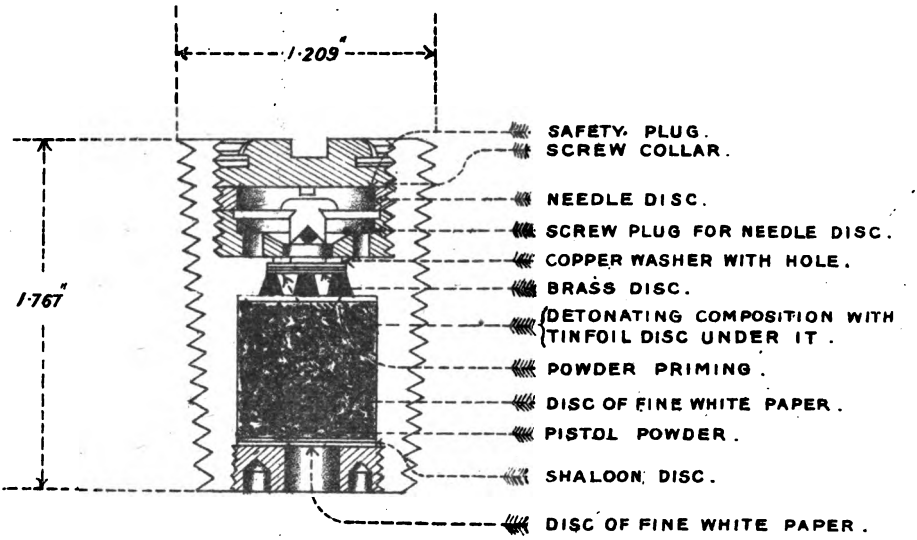
SECTIONAL ELEVATION.

FUZE, PERCUSSION DIRECT ACTION, Nº 3,

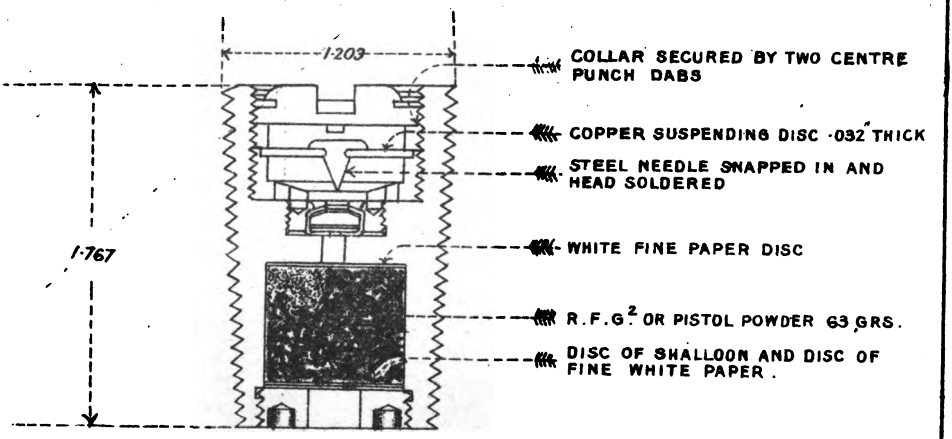
WITH PLUG.

FULL SIZE

MARK III.



MARK IV.



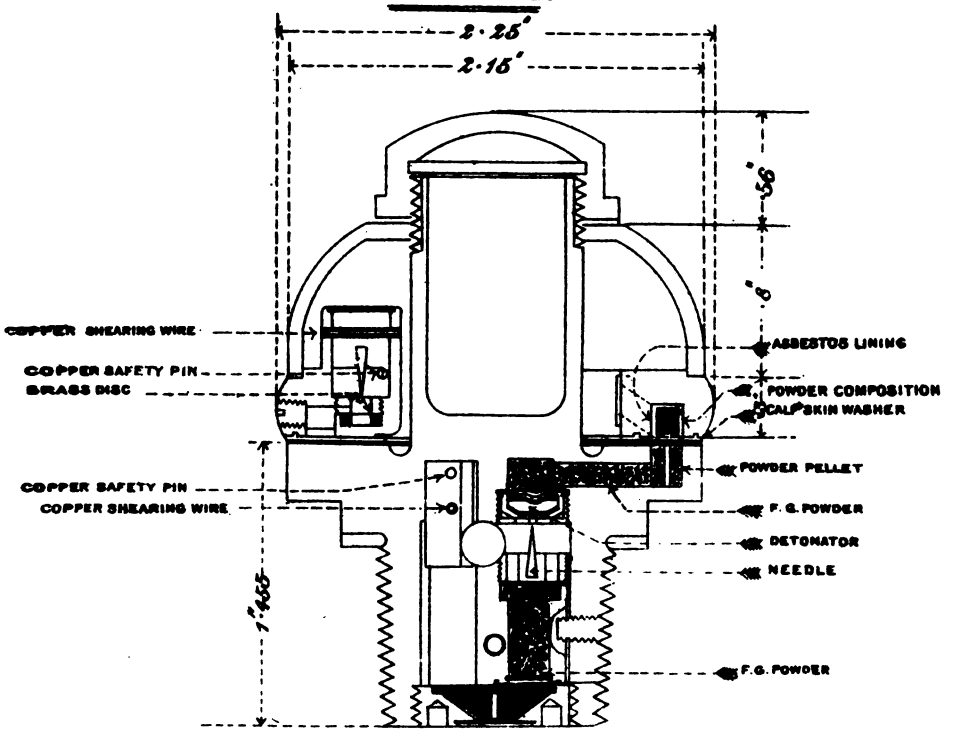
FULL SIZE.

4805·1·04.

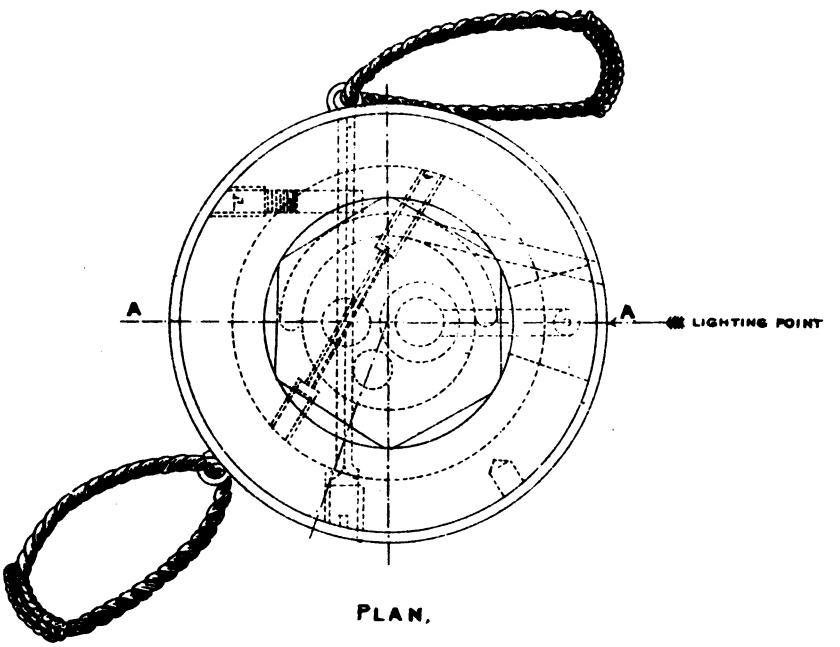
Weller & Graham, Ltd Litho. London.

FUZE, TIME AND PERCUSSION, MIDDLE, N°54, MARK III.

FULL SIZE.



SECTION AT A.A.



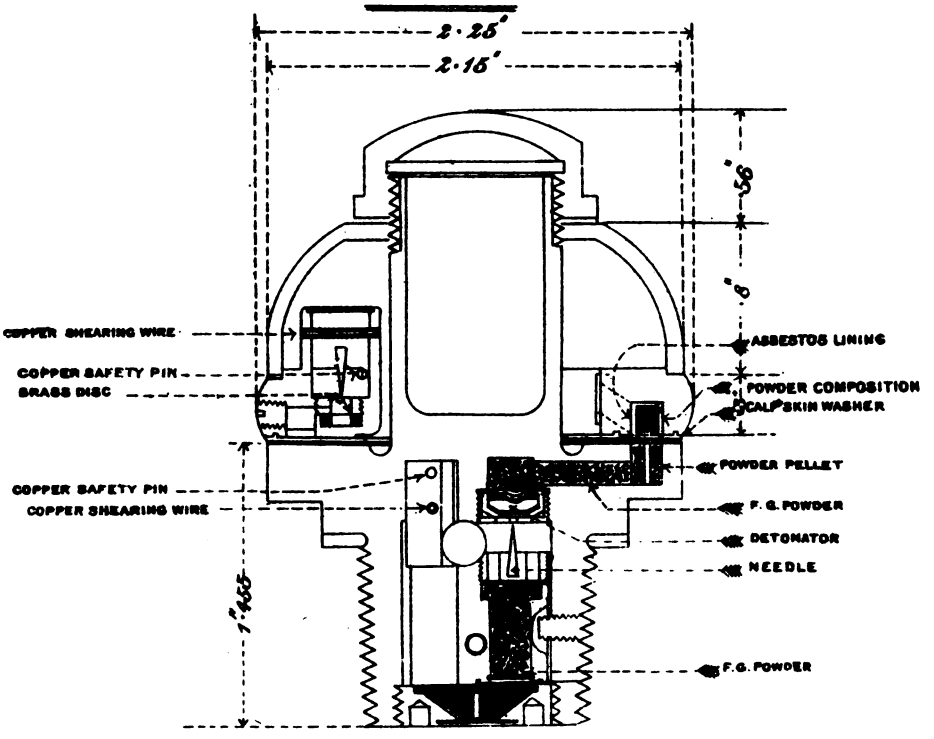
PLAN.

4605.1.06.

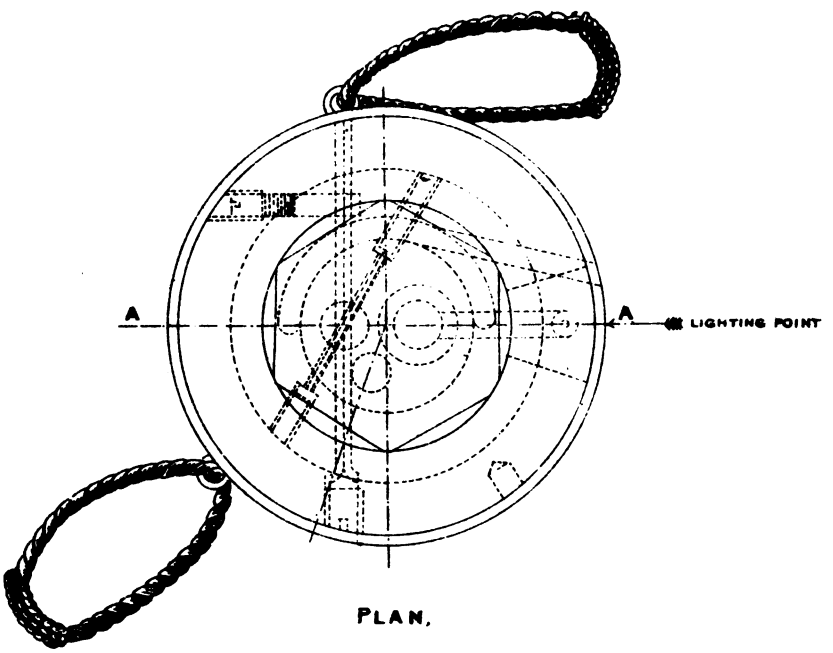
Weller & Graham Lth Litho. London

FUZE, TIME AND PERCUSSION, MIDDLE, No. 54, MARK III.

FULL SIZE.



SECTION AT A.A.



PLAN.

4605.1.04.

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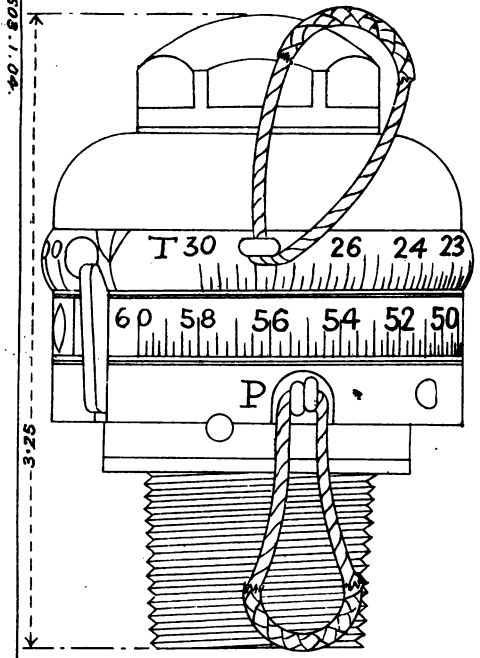
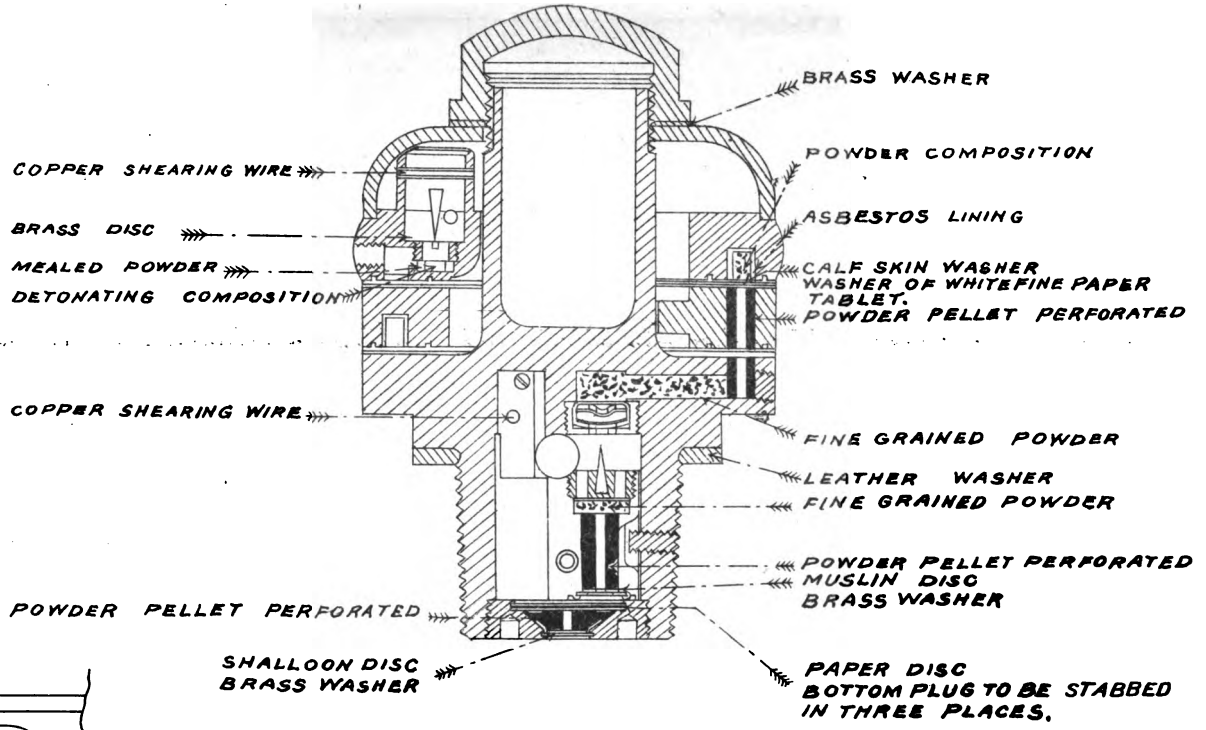
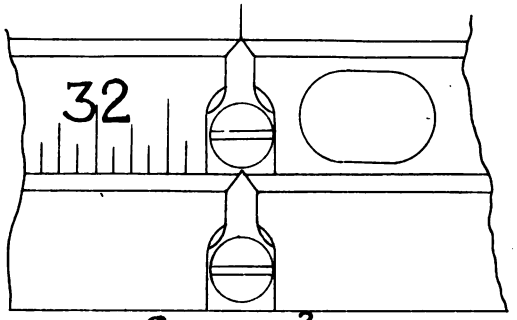
4608 1.04.





SCALE 1/1



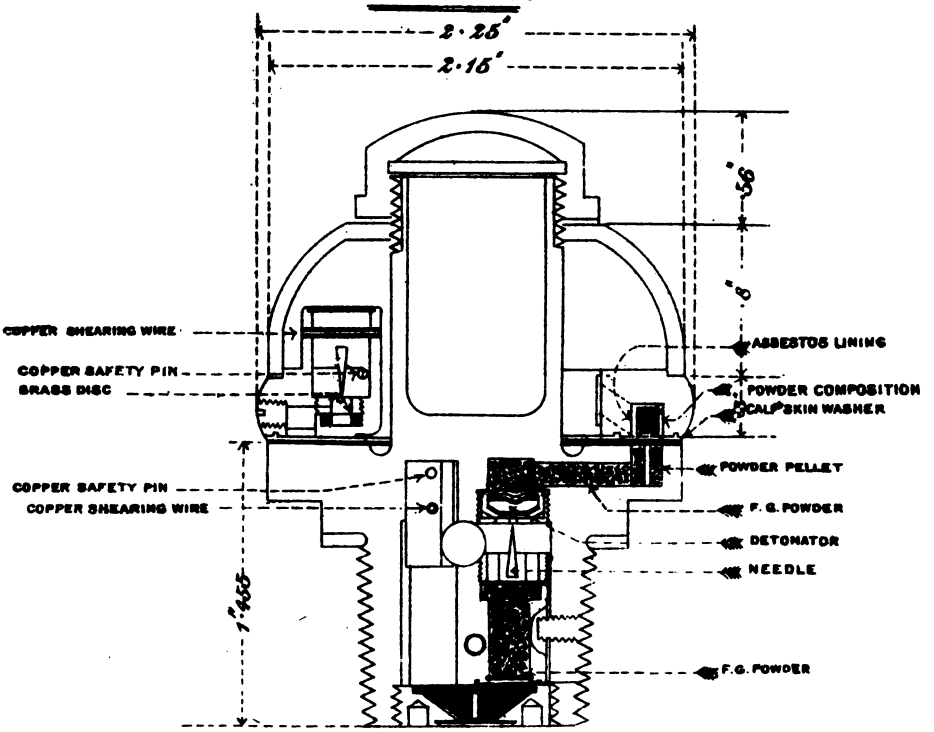
SCALE 2/1

FUZE, TIME & PERCUSSION, No 62 (MARK I)

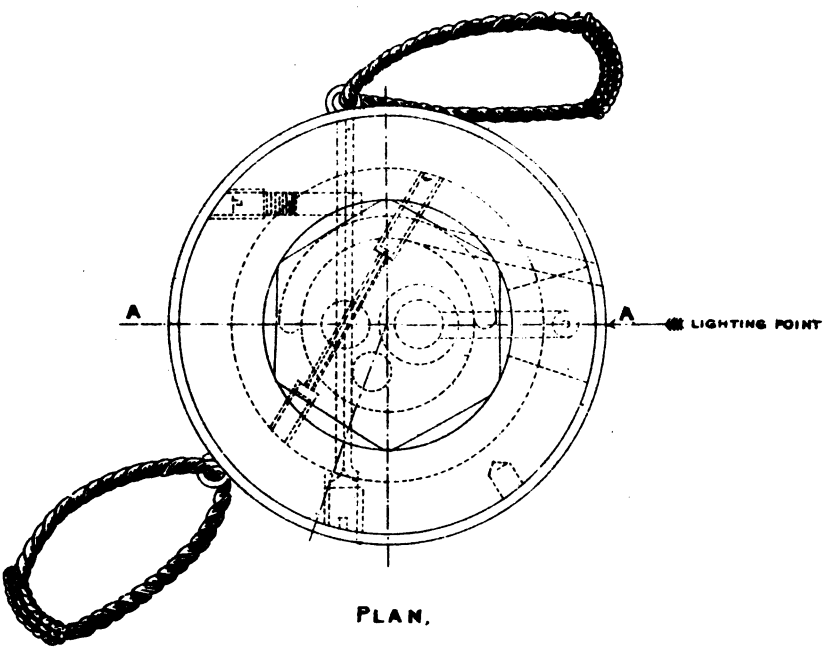
Plate LVIII.

FUZE, TIME AND PERCUSSION, MIDDLE, N°54, MARK III.

FULL SIZE.



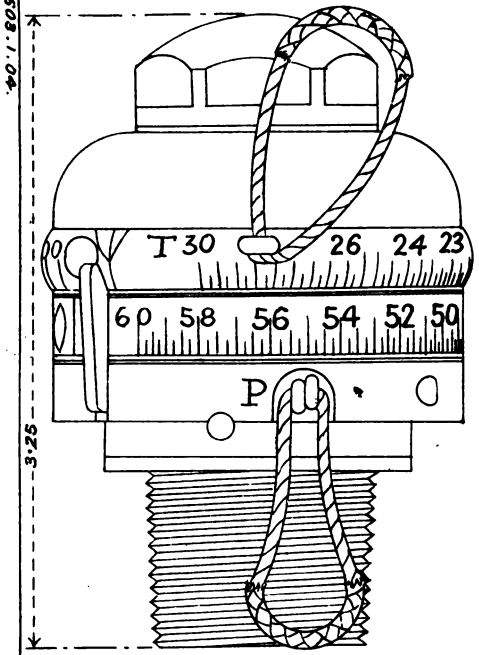
SECTION AT A.A.

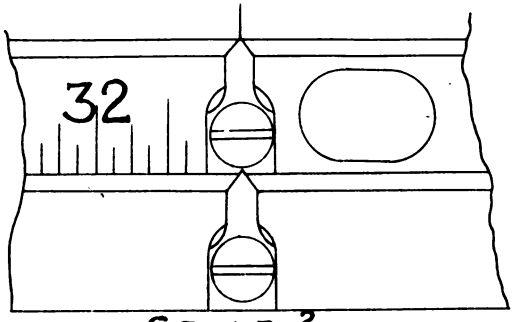


PLAN.

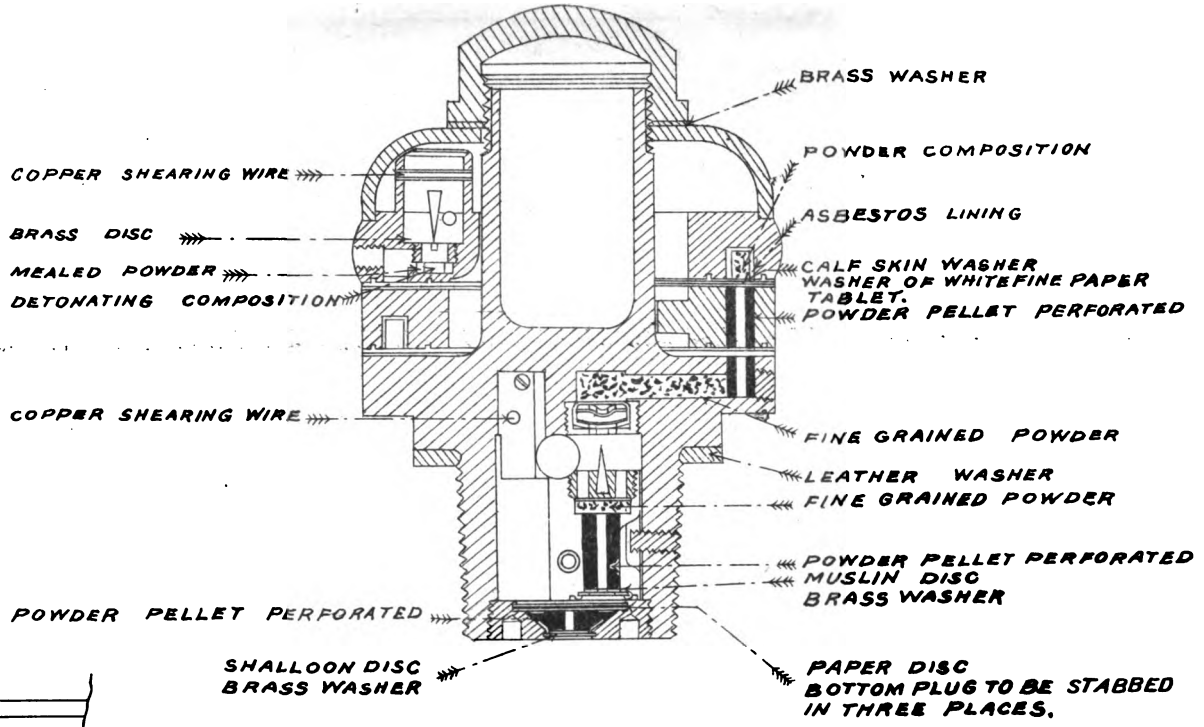
4505.1.04.

Weller & Graham Lt Litho. London.





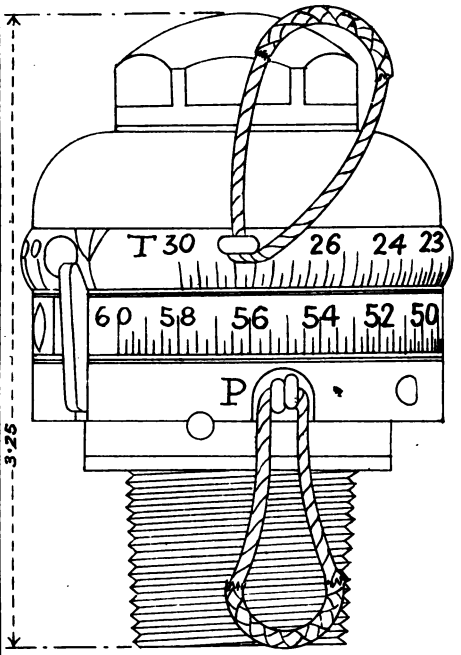
SCALE 2/1

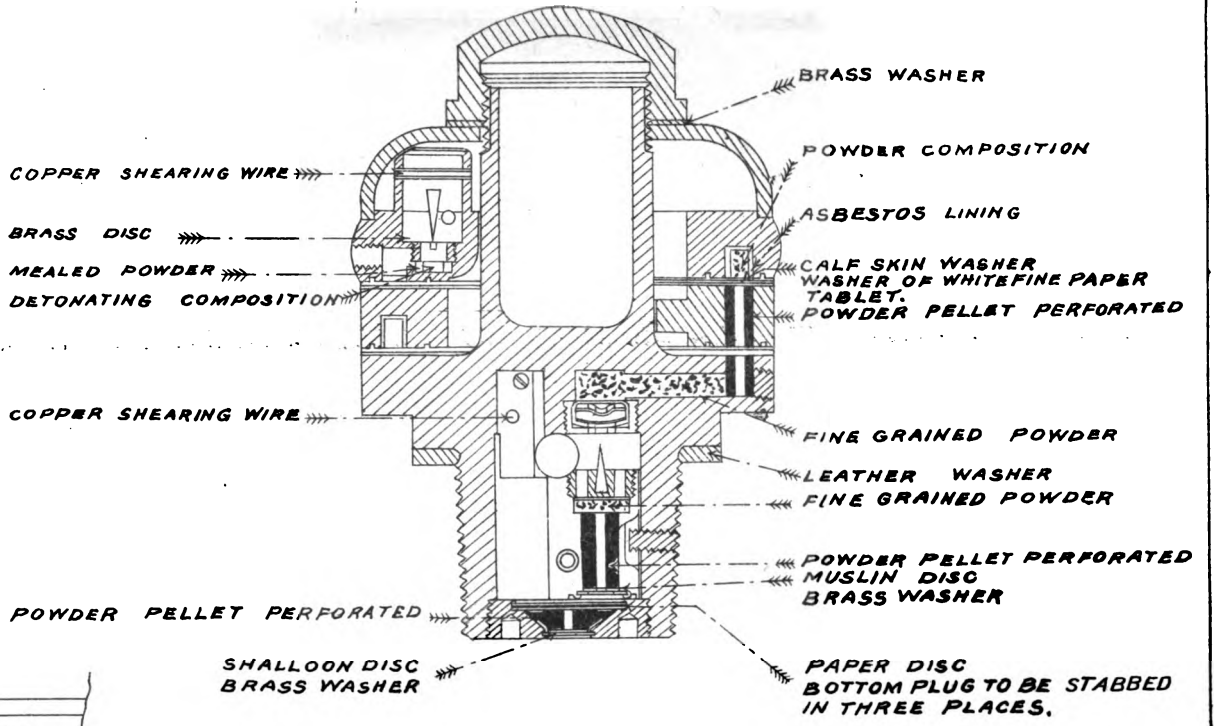


SCALE 1/1

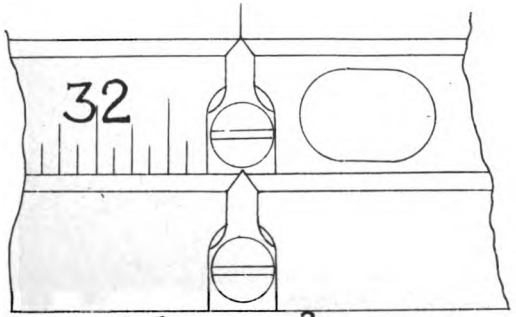
FUZE, TIME & PERCUSSION, Nº 62 (MARK I)

Plate LVIII.





SCALE 1/1



SCALE 2/1

FUZE, TIME & PERCUSSION, Nº 62 (MARK I)

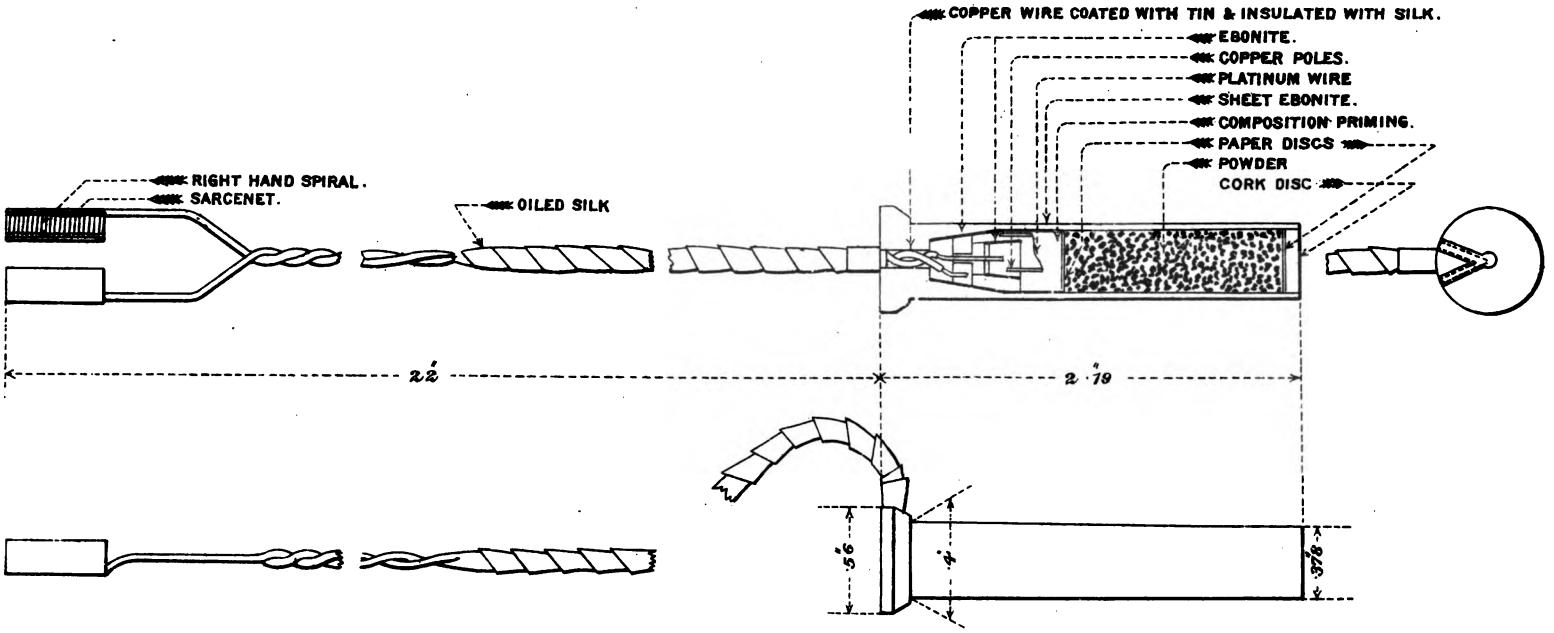
Plate LVIII.

Weller & Graham, Ltd. Litho. Londn.

TUBE, VENT-SEALING, ELECTRIC, P., MARK VII.

BRASS.

FULL SIZE.



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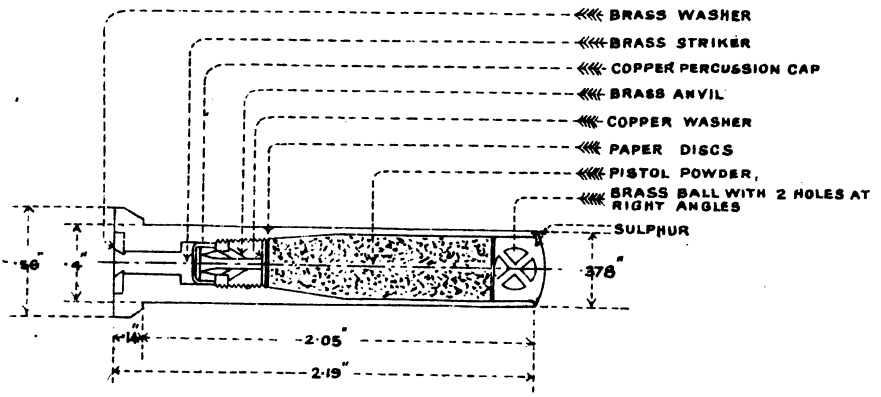
TUBE, VENT-SEAL, PERCUSSION. MARK III.

BRASS

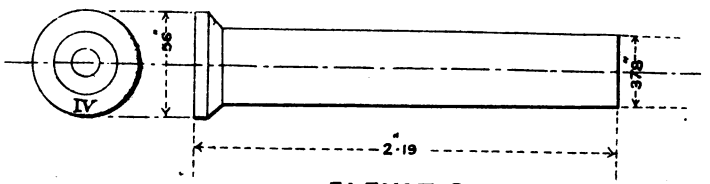
FULL SIZE



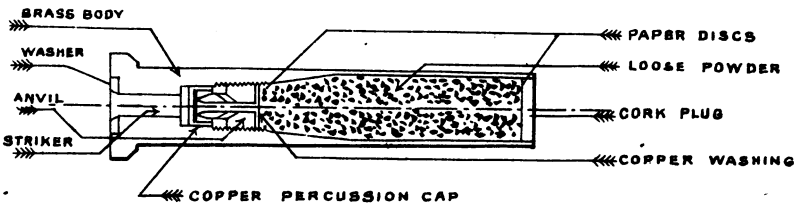
TUBE, VENT-SEALING, PURCUSSION, MARK IV.

BRASS

FULL SIZE



ELEVATION



SECTION

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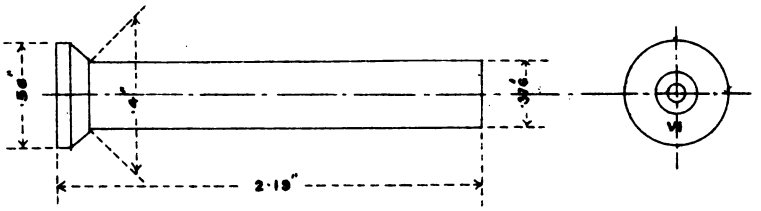
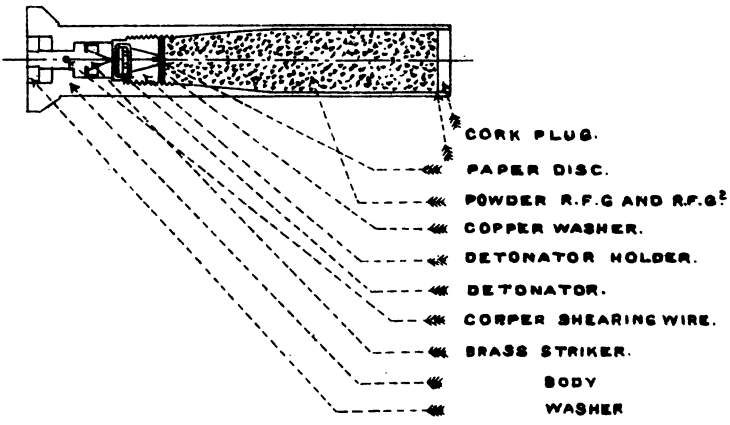
TUBE, VENT SEALING, PERCUSSION. (Mk. VI).

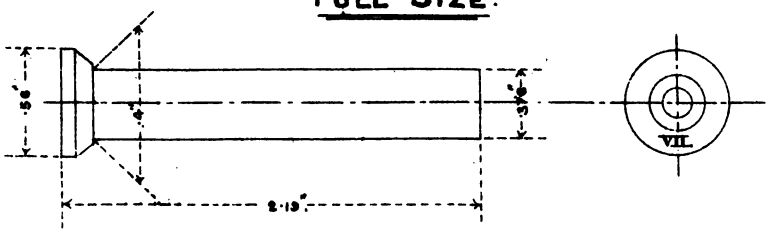
FULL SIZE.

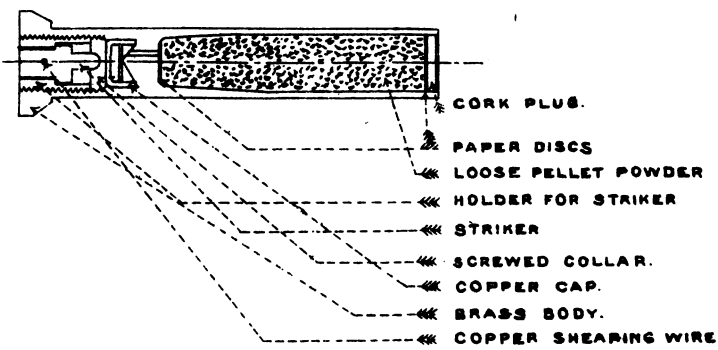




TUBE, VENT SEALING, PERCUSSION. (Mk. VII.) C

FULL SIZE.





4905, 1.04.

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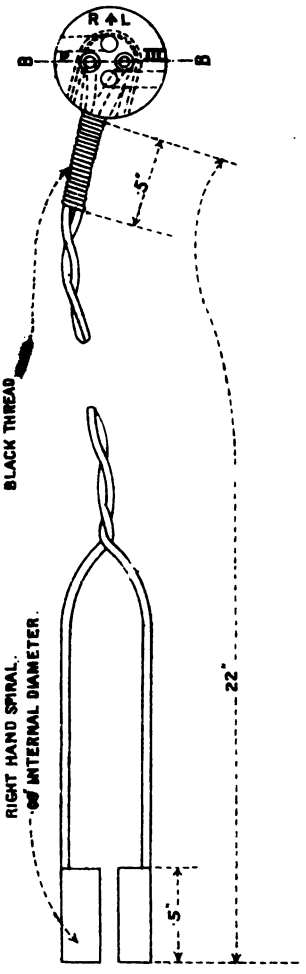
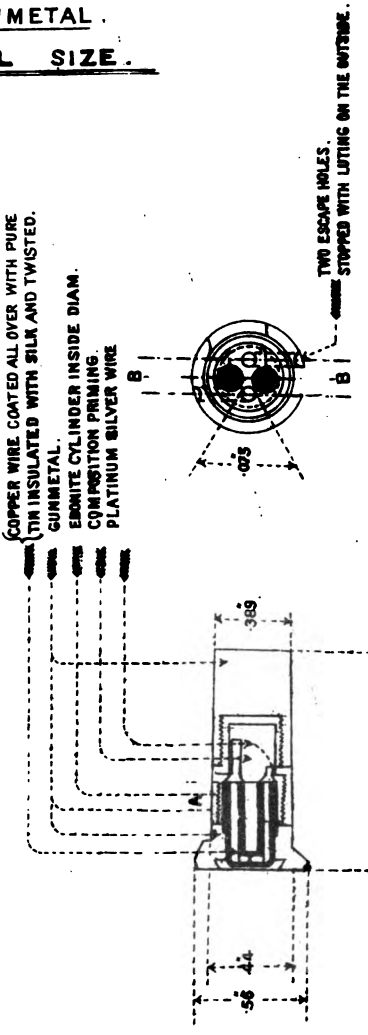
TUBE, VENT-SEALING, ELECTRIC, P. DRILL, MARK III.

GUNMETAL.

FULL SIZE.



END ELEVATION



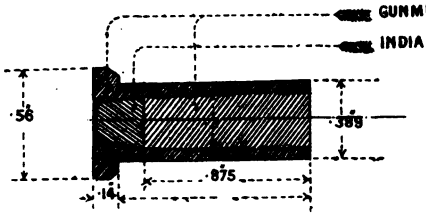
SECTION AT A.A.

SECTION AT B B.

TUBE, VENT-SEALING, ELECTRIC, P. DRILL, MARK III.

GUNMETAL

FULL SIZE.



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